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Evaluation of Tropospheric Ozone concentration in two Urban Roads of Manaus - Am

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Abstract*— *This main objective is to evaluate the concentration of Ozone (O3) in the low troposphere of two main urban roads of Manaus, thus identifying the possible impacts of this element on human health and the environment. For this work, weekly data were collected in September, a period characterized as dry in the region. The data were treated according to the hourly average of the concentrations that were established from 10 to 15h UTC, based on the values collected by RESOLUTION CONAMA 491/2018 that presents the criteria of air quality standards. The results demonstrated high peaks in the ozone concentration, but were within compliance, since in most of the monitoring time the concentrations were in accordance with the legislation in force.

***Keywords*— *Tropospheric ozone, air pollution, air quality*.**

I. INTRODUCTION

Population growth contributes directly and indirectly to increased air pollution through ozone (FERNANDES, 2017). In recent years with the intensity of anthropic activities the air quality in large cities has become a problem, because fleets of vehicles in circulation on the streets of cities have multiplied, causing concern about the issuance of pollutants launched into the atmosphere, the gases generated by industries and the burning of fossil fuel by automotive vehicles has been causing damage to public health (SILVA 2014; PAZZAGNOLO 2013).

Costa (2015), describes that tropospheric ozone is a secondary pollutant formed in the atmosphere and naturally developed in the stratosphere by the photochemical action of ultraviolet rays on oxygen molecules, the gases that combine for this process are nitrogen oxides and carbon. For Pazzagnolo (2013), the formation of ozone from the burning of fosseis fuels, gases emitted by industries and fires, forms caused by anthropic actions, but has the natural means of emitting gases such as natural fires and volcanic activities.

Ozone is a gas that has multiple functions in the atmosphere according to the altitude at its time, in the stratosphere is considered a beneficial gas because it filters ultraviolet radiation of type B (UV-B) that are harmful to living beings (PACHECO J., 2018). However in the troposphere ozone loses its protective utility and converts into a polluting gas in which it is responsible for increasing surface temperature, grouped with carbon monoxide (CO), carbon dioxide (CO2), methane (CH4) and nitrous oxide (BRANCO et. al., 2013).

Vehicles and industries launch into the atmosphere a large amount of carbon monoxide, which alone is not such a dangerous pollutant to human health, but on the other hand, when interacting with solar radiation, a photochemical reaction occurs occurring in transformation for tropospheric ozone (COSTA, 2015; PAZZAGNOLO, 2013; SANTOS et. al., 2016). This interaction was shown in Alabarse (2016), which states that ozone is a very harmful pollutant to the health of the population, while Silva (2017), presents ozone as the main pollutant causing respiratory disease problems. According to the Ministry of Health diseases such as: bronchitis, asthma, allergic rhinitis, lung cancer, ischemic diseases that cause the infarction have grown as well as exposure to O3 throughout the country especially in urban centers and states where it has a high rate of Burned (OMS, 2018).

Due to the probable effects of ozone on health, silva's (2019) and Silveira (2019) studies showed an evaluation of ozone concentration based on CONAMA Resolution No. 481/2018, where limits are determined in relation to exposure to O3, both considered the importance of the values established in this.

According to CONAMA Resolution No. 481/2018 establishes values for ozone concentration that is 140 µg/m3 at an average of eight hours per day, for world health organization (WHO) the defined value is 100 µg/m3.

This article will show a study in which evaluated the concentration of O3 in two avenues of great circulation of vehicles in the city of Manaus / AM, presenting differences in the afforestation of them. At the

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same time, it was possible to analyze the impact of vegetation on the concentration of pollutants.

II. MATERIALS AND METHODS

For the realization of this research, two urban roads of Manaus / AM were selected, in which both have a greater flow of vehicles in circulation. Avenida Brasil where data was collected near the Children's Emergency Room that will be called study area 1, this has a variety of vegetation as shown in Figure 1, and Constantino Nery Avenue that was collected in front of fametro college characterized as unit 3, called study area 2.

Fig.1 – Study area 1, Avenida Brasil.
Source: Google Earth, 2019.

Fig.2 - Study area 2, Constantino Nery.
Source: Google Earth, 2019.

Data were collected on days 09, 12, 16, 19, 23, 26 and 30/09, with the exception of day 03/10, which occurred precipitation record which made it impossible to measure. Thus, the measurements were carried out during four weeks during mondays on Avenida Brasil and Thursdays at Constantino Nery Avenue, at the time of 10 to 15h UTC. Measurements were performed 10 minutes before and after full hour, in an interval of 2 minutes. Additionally, the measurements were performed at a predetermined fixed point on the two avenues where there is a greater flow of motor vehicles, this regime occurred during all the days when the collections took place. Two equipment was used, the Term – Hygrometer used to measure humidity and temperature along with the pom portable meter (Personal Ozone Monitor) this measured the concentration of tropospheric ozone and pressure on both avenues. The Term – Hygrometer is an equipment that has the following features, LCD display, dimensions 130 x 7 x 18mm, power 1 AAA battery, weight 150g, a cable that measured approximately one meter and function °C and °F.

The POM device has dimensions of 4x3 x 1.5 inches and passes only 0.8 Ib/ 1.0 Ib without/ battery (360g/ 450g). The POM was established by the U.S. EPA as a federal equivalent method (EmF) for O3. The mechanism used was the same for the two equipment, the POM and term were connected – hygrometer these were connected for 1 minute for self-calibration past the minute began measurements. First the POM was used after the Term - Hygrometer, this process lasted on average 2 minutes for each device.

The collected data were recorded in a table covering items such as date, time, O3 values, temperature, relative air humidity and pressure. After finishing field collections, the data set obtained began to be scanned in Excel for the comparison of information, in which it will be analyzed cautiously and thus begin to build the results of this work.

The city of Manaus/AM has a peculiar feature of providing services of autonomous street vendors such as snack suppliers and breakfast that are directly exposed to air pollution over a long period of time and at times of greater circulation of cars and incidence of solar radiation. Thus, the choice of taking measures at a fixed point allowed to obtain an overview of the degree of exposure of inhabitants who are exposed daily to air pollution.

III. RESULTS AND DISCUSSIONS

Figure 3 shows the average records of the surface ozone concentration (O3) on 09, 12, 16, 23, 26 and 30 at times from 10 to 15h UTC. It was observed that there is a growth in the values of concentrations during the period of 12 and 15h, a time with a higher incidence of solar radiation which contributes to the formation of O3 on the surface. These results agree to those presented by Costa (2015) and Alves and Alves (2019) in their analyses in the city of Manaus and Lamarão do Passé - Bahia, respectively.

Figure 3 also shows that on days 09, 12, 16 and 19/09 the pollutant concentration presented lower values in relation to the other days analyzed, which ranged from 3 to 17 ppb, succeeding at times between 10 and 13h. On the other hand, on 12/09, a strong increase in concentration was recorded around 38 ppb at 3:00 p.m., which was not noticed

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in the other days analyzed. This increase in training at 3 pm may have a strong influence of high temperature during this time, unlike the relative humidity of the lower air, as shown in Figure 4 (WALLACE AND ROBBS, 2006) .

Maximum ozone concentrations were recorded during the days 23, 26 and 30/09 in the period from 12 to 15h, presenting concentrations around 41ppb. Despite the high registration, the concentrations did not exceed what was established by CONAMA Resolution No. 491/2018 which is 140 µg/m3 (71.4 ppb) and the defenid by who which is 100 µg/m3. However, in Alves and Alves (2019) concentrations exceeded 51 ppb, as the hours of the day advance, increase the temperature records, around 35°C while humidity 53%, which caused interference in the concentration of pollutant.

According to Figure 3, on 26/09 between 14 and 15h due to rain, no records were made, which decreased to zero the concentration of the pollutant. Nevertheless, it was found that before the occurrence of rain the concentration increased rapidly, presenting a higher concentration value of ozone around 41ppb, the atmosphere was stable thus affecting the results.

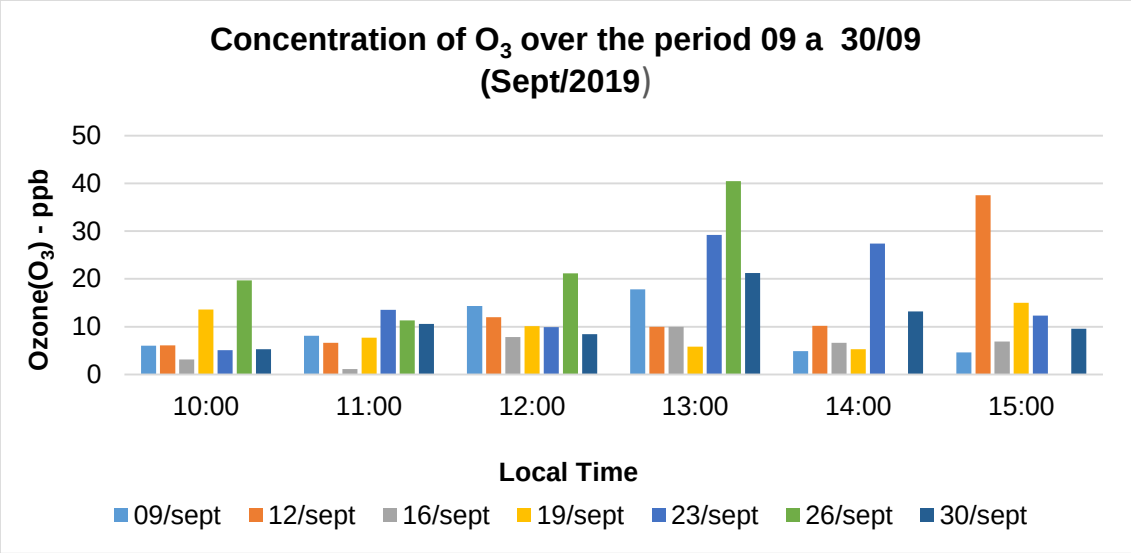

Fig.3 - Concentration of the average O3 for the month of September.

Analyzing Figure 4, it is observed that this period of September was very dry, presenting high temperatures, and the relative humidity of the air becomes lower and varies as the temperature increases. On the other hand, Dutra (2012) showed that in the period from July to September are the months defined as the driest in the region. Thus, the temperature and humidity averages for data collection days is notorious that temperature has high values and added to the intense flow of vehicles thus promotes ozone formation (Figure 4).

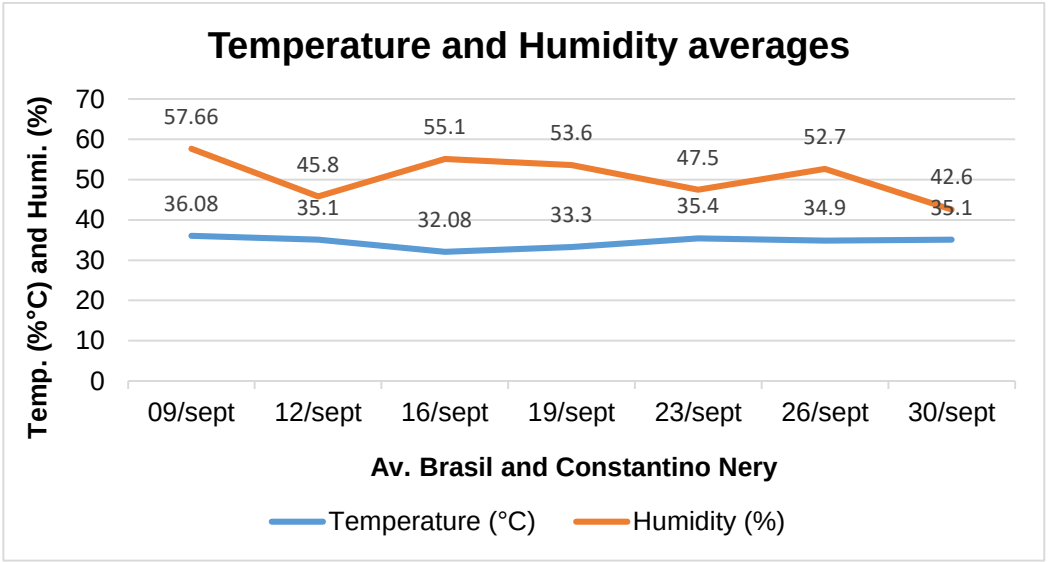

Fig.4 - Temperature and Humidity Averages for the month of September.

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There were lower ozone concentrations on Avenida Brasil ranging from 1 to 29 ppb in relation to the records shown in Figure 6. This fact may be related to existing vegetation on site. These results agree those aprees in the study by Delabio and Sobage (2013) and Moura et al. (2004) who report that vegetation has a strong absorption of pollutants in the atmosphere, softening the concentrations launched.

Still, during the day 16/09 there was a decrease in the concentration of ozone around 1 ppb at 11am in the morning. This was due to precipitation records by inmet (National Institute of Meteorology) during the period of 9 mm accordingly, which plays the role of "washing the atmosphere", decreasing the concentration in the low atmosphere, especially CO2, which associated with oxidized solar radiation, generating ozone.

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This avenue has a high flow of vehicles, due to its strategic location of access to the bridge over the Rio Negro, connects the capital of Amazonas the satellite cities, in addition, this route presents a great movement of street walkers.

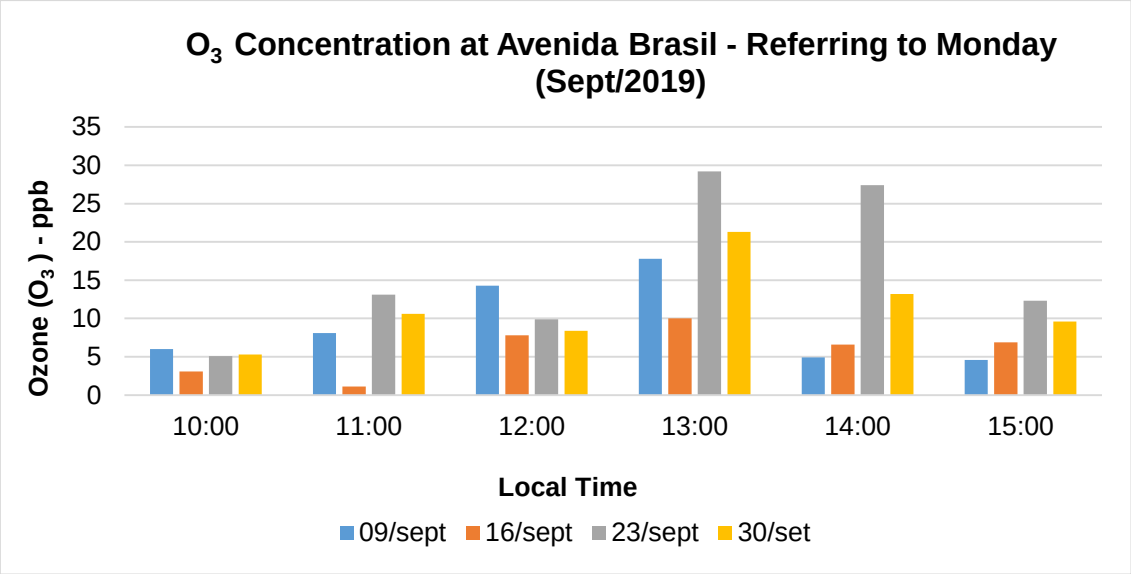

Fig.5 - Concentration of O3 Avenida Brasil.

Figure 6 shows high concentrations, but which on the other hand did not exceed what was allowed by CONAMA Resolution 481/2018 and who. The highest record was around 40.5 ppb on 9/26, within the required standards. However, Constantino Nery Avenue presents a large flow of motor vehicles in circulation which contributes to the high concentrations of pollutant, when compared to Avenida Brasil.

On 12/09 had a high in the concentration of ozone 37ppb at 15h, the temperature at 36°C and low humidity, this high concentration occurred at the time of highest flow vehicles. It is noteworthy that in this period of collection Constantino Nery Avenue was under construction which caused slower and congested traffic of vehicles. Likewise, Freitas (2012) states that intense flows of cars emit pollutants into the atmosphere and thus contributing to the formation of ozone. At the same time, Costa (2015) and Calderaro (2016) report in their studies that the month of September in Manaus which was conducted this study is characterized in the region being as the warmest period, with the highest solar incidence, due to these photochemical specificities of ozone, its production multiplies at this time because the solar incidence is high.

The burning of fuel fosseis of vehicles and industries are still the main precursors of ozone formation in Curitiba and São Paulo (ANTUNES, 2008 and POLLI, 2011). These results do not differ much from Manaus, already in this study was used the two of the main avenues of the city, where it has an intense vehicle traffic and consequently a higher concentration of ozone is obtained.

Also, Figure 6 shows that on 9/26 ozone obtained its highest peak value (40.5 ppb) at 1pm, although ozone is quite high still does not cause any danger to human health, because according to RESOLUTION CONAMA 481/2018, this high would only be harmful to salute when exposure to pollutant is eight hours.

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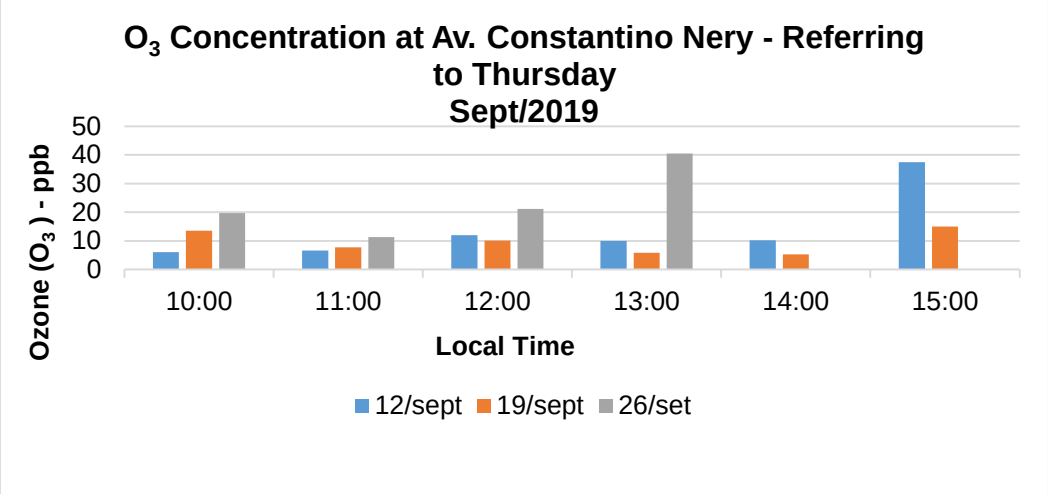

Fig.6 - Concentration of O_3 Constantino Nery Avenue.

IV. FINAL CONSIDERATIONS

This work showed a punctual study of the concentration of O3 in two urban roads of intense flow of vehicles in the city of Manaus / AM. The city has a large number of services performed by self-employed street vendors such as snack suppliers and breakfast that are directly exposed to air pollution over a long period of time and at times of greater circulation of cars and incidence of solar radiation.

The maximum concentrations were recorded between 10 and 15h, a period in which solar radiation was intense, even because the month of September is characterized as a dry month in the region. According to CONAMA Resolution No. 491/2018 and the World Health Organization (WHO) the results of ozone concentrations did not violate the limits established, although maximum sozone values have remained as required in the legislation in force.

Although the values obtained have been within compliance, it is important that this pollutant be monitored because when launched into the atmosphere it is harmful to human health. Being exposed daily for a short period of time, they can affect the health of people who are exposed to pollutants, especially street vendors. However, monitoring this pollutant is extremely relevant to society, because ozone can generate more respiratory diseases, thus compromising air quality.

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