Latin American Applied Research 40:267-273(2010)

CARBON MONOXIDE EMITTED FROM THE CITY OF BUENOS AIRES AND TRANSPORTED TO NEIGHBOURING DISTRICTS

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Abstract— **Air pollutants emitted in a city may reach neighbouring areas. This paper describes and applies a methodology for estimating the CO transported from the City of Buenos Aires (CBA) to neighbouring districts. The methodology is applicable only for inert pollutants. This preliminary evaluation shows that 32% of CO annually emitted is transported to the de la Plata River. The smallest fraction (7.5% of annual emission) goes to the district of Avellaneda. The main factors controlling the outflow flux of CO are evaluated and their relative importance is discussed. It is also evaluated that the CO emissions in the CBA may contribute to 8h-CO background concentrations in the Metropolitan Area of Buenos Aires (MABA) with more than 10% of the Air Quality Standard. The districts of the MABA located west and northwest the CBA are the more affected by the CO emitted in the CBA.**

Keywords— **Air quality management; Air pollution impact; Buenos Aires; Carbon monoxide.**

I. INTRODUCTION

The urban atmosphere is subjected to large inputs of anthropogenic contaminants arising from both stationary (power plants, industries, commercial and residential heating and cooking) and mobile sources (traffic and transportation). Urban air pollution poses a significant threat to human health and the environment throughout both the developed and developing world. There are studies (Fenger, 1999; Molina and Molina, 2004), which highlight the atmospheric pollution problems in large cities and the need to establish air pollution management and control programs. Within the framework of an urban air quality management system, atmospheric dispersion models provide a link between the source emissions and ambient concentrations. Urban dispersion models range from simple empirical models to complex three-dimensional urban air-shed models. Some examples of these models are the UAM model (Morris and Myers, 1990), the DAUMOD model (Mazzeo and Venegas, 1991); the UK-ADAMS Urban model (Carruthers *et al.*, 1994); the Danish OML model (Olesen, 1995); the UDM-FMI model (Karppinen *et al.*, 2000). Complex models may include some aspects of the microclimate of a city (e.g., temperature inhomogeneity, local circulations). The combination of complex models with local measurements would improve results of pollutant dispersion in an inhomogeneous urban area (Mikhailuta *et al.*, 2009). Sometimes unavailable input data make application of complex numerical tools not possible, and simple urban background pollution models become an acceptable alternative (Berkowicz, 2000; Hanna *et al.*, 2002; de Leeuw *et al.*, 2002).

Air pollutant emissions within cities deteriorate local urban air quality. Furthermore, cities interact with their surroundings by exporting and importing pollution. The City of Buenos Aires (CBA) (34°35'S – 58°26'W) is a city-state and the capital of Argentina. It has an extension of 203km^2 and 2776138 inhabitants (INDEC, 2002) and is located on the west coast of the de la Plata River. The CBA is surrounded by 24 districts that belong to the Province of Buenos Aires (the "Greater Buenos Aires", GBA). The GBA has an extension of 3627km^2 and 8684437 inhabitants (Fig. 1).

Each of the 24 districts has its own local government. At each district, its local environmental authority is required to evaluate the air quality condition and to define and implement air-pollution control measures for local sources. Therefore, knowledge of the amount of air pollutants coming from the CBA is useful for im-

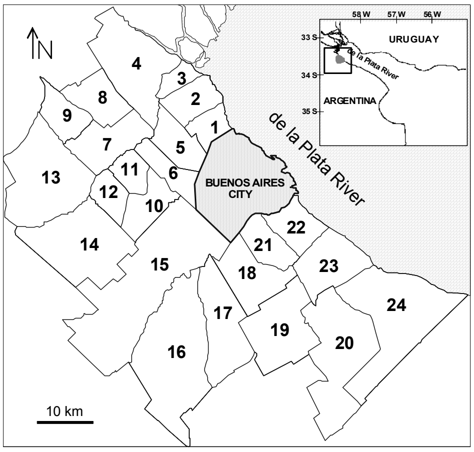

Fig. 1. Map of the Metropolitan Area of Buenos Aires, including the City of Buenos Aires and the Greater Buenos Aires. Districts of the Greater Buenos Aires: 1: Vicente López; 2: San Isidro; 3: San Fernando; 4: Tigre; 5: San Martín; 6: Tres de Febrero; 7: San Miguel; 8: Malvinas Argentinas; 9: José C. Paz, 10: Morón; 11: Hurlingham; 12: Ituzaingó; 13: Moreno; 14: Merlo; 15: La Matanza; 16: Ezeiza; 17: Esteban Echeverría; 18: Lomas de Zamora; 19: Almirante Brown; 20: Florencio Varela; 21: Lanús; 22: Avellaneda; 23: Quilmes; 24: Berazategui.

plementing an Air Quality Management Plan at neighbouring districts. The CBA and the GBA form the Metropolitan Area of Buenos Aires (MABA), which is considered the third megacity in Latin America, following Mexico City (Mexico) and Sao Paulo (Brazil). The MABA is located on a flat terrain with height differences less than 30m. The de la Plata River is a shallow estuary of 35000km^2, approximately. It is 320km length and in front of the city, its width is about 42km. The de la Plata River plain has a temperate climate. Annual mean wind speed is 4.7m s^{-1} and the annual frequency of calms is 1.6%. The wind blows clean air from the river towards the city 58% of the time. Breeze circulations over the wide estuary of the de la Plata River could bring pollutants back to the city and its surroundings. However, the frequency of atmospheric recirculation events over the city is small: 8% in summer, 7% in autumn, 5% in winter and 7% in spring (Venegas and Mazzeo, 1999).

In the City of Buenos Aires there are three Thermal Power Plants situated in the coastal region and some small industries. In addition, more than two million vehicles circulate daily on the streets of the city. Mazzeo and Venegas (2003) developed a first version of CO and NO_x (as NO_2) emission inventory for the CBA. Recently an updated version including the emissions in the MABA has been developed (Pineda Rojas *et al.,* 2007). These inventories include: a) area sources: residential, commercial, small industries, aircrafts landing/take-off at the domestic airport, and road traffic and b) point sources: stacks of the Power Plants. Since the Power Plants burn natural gas most of the year and consume fuel oil as much as twenty days in wintertime only, they are responsible for 0.04% of CO annual emission in the city. For this reason, only the CO emitted from area sources is considered in this study. Road traffic accounts for 99.4% of CO annual emission in the city. The vehicle fleet composition is 79.8% passenger cars, 1.6% buses, 15% heavy-duty vehicles (HDV) and 3.6% motorcycles. Buses and HDV are mainly diesel and car fleet is composed by 78.9% petrol, 16.0% diesel and 5.1% GNC (compressed natural gas). Estimated CO annual emission from area sources in the CBA is 324.7Gg year^{-1} (Pineda Rojas *et al.*, 2007).

The air quality in the city has been the subject of several studies carried out during the last years. Some of these studies analysed data obtained from measurement surveys of pollutants in the urban area (Bogo *et al.*, 1999; 2001; 2003; Venegas and Mazzeo, 2000; Mazzeo and Venegas, 2002; 2004; Mazzeo *et al.*, 2005; Bocca *et al.*, 2006). Other studies reported results on the application of atmospheric dispersion models (Venegas and Mazzeo, 2006a; 2006b). In the Greater Buenos Aires, very few air quality measurements have been made (Fagundez *et al.*, 2001; SAyDS, 2002).

The objective of this study is to describe and apply a methodology for estimating the CO transported from the City of Buenos Aires to neighbouring districts. The methodology is applicable only for inert pollutants. In addition, the contribution of CO emissions in the CBA to background concentrations in neighbouring districts is evaluated.

II. CO TRANSPORTED FROM THE CBA TO NEIGHBOURING DISTRICTS

This section includes the description and application of the methodology developed to evaluate the air pollutant transported from the city to neighbouring districts.

A. Methodology

The proposed methodology considers that the city is divided into square grid cells with vertical extensions given by the upper boundary of the plume at each grid cell. The air pollutant transported (F) (mass time^{-1}) across the border of the city at a grid cell to a neighbouring district, can be estimated by the following expression:

$$F = \Delta l \int_{z_0}^{h} C(x,z)\; u_n(z)\, dz \qquad (1)$$

with the x-axis in the direction of the mean wind and the z-axis vertical, Δl is the length of the border between the neighbouring district and the city at the grid cell, z_0 is the surface roughness length, h is the vertical extension of the plume at the grid cell, C(x,z) is the air pollutant concentration at the grid cell and $u_n(z)$ is the wind velocity component perpendicular to the city border at the grid cell. Considering that the border between the city and a district named "k" extends along a number M_k grid cells, the air pollutant transported to this district (F_k) is estimated as

$$F_k = \sum_{j=1}^{M_k} \left(\Delta l \int_{z_0}^{h} C(x,z)\; u_n(z)\, dz \right)_j \qquad (2)$$

"j" (=1…M_k) indicates each grid cell where there is a border between the district "k" and the CBA. There is a perfect overlapping between the M_k grid cells and the border of the "k" district. The wind velocity component (u_n) perpendicular to the city border in each grid cell can be obtained knowing wind speed (u) and the direction of airflow vector (θ) measured from the North. Considering (ω) the direction of the vector perpendicular to the external face of the city boundary, also measured from the North, results $u_n(z)=u(z)\cos(\theta-\omega)$ (Fig. 2). The transport of mass of air pollutant from the city towards its surroundings occurs only if $\cos(\theta-\omega)>0$.

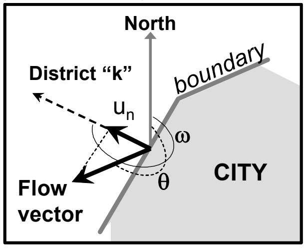

Fig. 2. Evaluation of the wind velocity component (u_n) perpendicular to the city border.

In this application, the expressions and parameterizations included in the urban atmospheric dispersion model DAUMOD will be considered. A description and several applications of this model can be found in

Mazzeo and Venegas (1991), Venegas and Mazzeo (2002), (2006a), (2006b), Pineda Rojas and Venegas (2008), Mazzeo and Venegas (2008). The performance of DAUMOD model in estimating background concentrations has been evaluated comparing estimated and observed concentration values for several cities. Results for Bremen (Germany), Frankfurt (Germany) and Nashville (USA) have been reported in Mazzeo and Venegas (1991) and for Copenhagen (Denmark) can be found in Venegas and Mazzeo (2002). The validation of DAUMOD to estimate CO and NO_x (as NO_2) background concentrations in the CBA can be found in Mazzeo and Venegas (2004) and Venegas and Mazzeo (2006a). DAUMOD results show that the performance of the model in estimating short-term background concentrations (hourly and daily) in the City of Buenos Aires is good and it improves when estimating long averaging time values (monthly and annual).

Equation (2) is integrated considering the expressions for C(x,z) and u(z) included in the urban atmospheric dispersion model DAUMOD. C(x,z) is given by the polynomial form (Mazzeo and Venegas, 1991; Venegas and Mazzeo, 2006a, 2006b):

$$C(x, z) = C(x,0)\left[\sum_{\alpha=0}^{6} A_\alpha \left(\frac{z}{h}\right)^{\alpha}\right] \qquad (3)$$

where

$$C(x,0) = \frac{a\left[Q_0\, x^{b} + \sum_{i=1}^{N} (Q_i - Q_{i-1})(x - x_i)^{b}\right]}{|A_1|\; k_v\, z_0^{\,b}\, u_*}$$

where Q_i (i = 0, 1, 2, …, N) is the uniform strength of each grid cell in which the urban area is divided located upwind the receptor, *a*, *b* and A_α (α=0, …, 6) are parameters that depend on atmospheric stability, k_v (=0.41) is von Karman's constant, u_* is the friction velocity and h is the vertical extension of the plume The reader can find the expressions of *a*, *b* and A_0 … A_6 in Venegas and Mazzeo (2002; 2006b) and Pineda Rojas and Venegas (2008).

The wind profile u(z) is given by:

$$u(z) = \frac{u_*}{k_v}\left[\ln\left(\frac{z}{z_0}\right) + \Psi\left(\frac{z}{L}\right)\right] \qquad (4)$$

for $z \le z_1$ (with z_1=100m) and u(z)=u(100m)=constant for $z > z_1$ (Arya, 2001), L is the Monin-Obukhov length and Ψ(z/L) functions determine stability correction due to stratification (Wieringa, 1980; Gryning *et al.*, 1987):

$$\Psi\left(\frac{z}{L}\right) = \begin{cases} 6.9\dfrac{z}{L} & \dfrac{z}{L} \ge 0 \\ 1 - \varphi^{-1}\left(\dfrac{z}{L}\right) & \dfrac{z}{L} < 0 \end{cases} \qquad \varphi\left(\frac{z}{L}\right) = \begin{cases} 1 + 6.9\dfrac{z}{L} & \dfrac{z}{L} \ge 0 \\ \left(1 - 22\dfrac{z}{L}\right)^{-1/4} & \dfrac{z}{L} < 0 \end{cases}$$

In calm conditions, DAUMOD model assumes u=1m s^{-1} and wind direction of previous hour.

Substituting C(x,z) given by Eq. (3) and $u_n(z)$=u(z) cos(θ–ω) in Eq. (2) and integrating analytically, the following expression for F_k is obtained:

$$F_k = \frac{u_*}{k_v}\sum_{j=1}^{M_k}\left(C(x,0)\cos(\theta-\omega)\, h\, \Delta l \sum_{\alpha=0}^{6}\frac{A_\alpha I_\alpha}{\alpha+1}\right)_j \qquad (5)$$

where I_α is given by

$$I_\alpha = \begin{cases} \ln\left(\dfrac{h}{z_0}\right) + \dfrac{\alpha}{\alpha+1}\left[1 - \varsigma_0^{\alpha+1}\right] + f_\alpha & h \le z_1 \\ \ln\left(\dfrac{z_1}{z_0}\right) + \dfrac{\alpha}{\alpha+1}\left[\varsigma_1^{\alpha+1} - \varsigma_0^{\alpha+1}\right] + g_{1\alpha} + g_{2\alpha} & h > z_1 \end{cases}$$

with

$$f_\alpha = \begin{cases} \varsigma_0^{\alpha+1} - 1 + 6.9\dfrac{h}{L}\left(\dfrac{\alpha+1}{\alpha+2}\right)\left[1 - \varsigma_0^{\alpha+2}\right] & \dfrac{z_0}{L} \ge 0 \\ \dfrac{(\alpha+1)}{h^{\alpha+1}}\displaystyle\sum_{n=0}^{\alpha}\dfrac{\alpha!\,h^{n}}{n!}\dfrac{(1-\gamma h)^{\frac{5}{4}+\alpha-n}}{\gamma^{1+\alpha-n}}\left[1 - \varsigma_0^{n}\left(\dfrac{1-\gamma z_0}{1-\gamma h}\right)^{\frac{5}{4}+\alpha-n}\right]\left[\prod_{m=0}^{\alpha-n}\left(\dfrac{5}{4}+\alpha-n-m\right)\right]^{-1} & \dfrac{z_0}{L} < 0 \end{cases}$$

$$g_{1\alpha} = \begin{cases} 6.9\dfrac{h}{L}\left(\dfrac{\alpha+1}{\alpha+2}\right)\left[\varsigma_1^{\alpha+2} - \varsigma_0^{\alpha+2}\right] & \dfrac{z_0}{L} \ge 0 \\ \left[1 - (1-\gamma z_1)^{1/4}\right]\left[1 - \varsigma_1^{\alpha+1}\right] & \dfrac{z_0}{L} < 0 \end{cases}$$

$$g_{2\alpha} = \begin{cases} \varsigma_0^{\alpha+1} - \varsigma_1^{\alpha+1} + 6.9\dfrac{z_1}{L}\left[1 - \varsigma_1^{\alpha+1}\right] & \dfrac{z_0}{L} \ge 0 \\ \dfrac{(\alpha+1)}{h^{\alpha+1}}\displaystyle\sum_{n=0}^{\alpha}\dfrac{\alpha!\,z_1^{n}}{n!}\dfrac{(1-\gamma z_1)^{\frac{5}{4}+\alpha-n}}{\gamma^{1+\alpha-n}}\left[1 - \left(\dfrac{z_0}{z_1}\right)^{n}\left(\dfrac{1-\gamma z_0}{1-\gamma z_1}\right)^{\frac{5}{4}+\alpha-n}\right]\left[\prod_{m=0}^{\alpha-n}\left(\dfrac{5}{4}+\alpha-n-m\right)\right]^{-1} & \dfrac{z_0}{L} < 0 \end{cases}$$

γ=22/L, $\zeta_0=z_0/h$ and $\zeta_1=z_1/h$.

The DAUMOD parameterization of the height (h) of the upper boundary of the plume is given by $(h/z_0) = a\,(x/z_0)^{b}$ (Mazzeo and Venegas, 1991; Venegas and Mazzeo, 2002; Pineda Rojas and Venegas, 2008). The outflow flux (F_k) can be estimated applying Eq. (5) on hour-by-hour basis.

B. Results

The amount of CO emitted from area sources located in the CBA that is transported to neighbouring districts and the de la Plata River, is estimated applying Eq. (5) with hourly data and considering a spatial resolution of 1x1km. One year of hourly meteorological information obtained at the domestic airport located in the CBA and hourly data of the CO emission inventory (Pineda Rojas *et al.*, 2007) have been used as input data. Taking into account the daily variation of CO emissions, two regimes are identified: "diurnal emission regime" (from 07:00AM to 09:00PM) and "nocturnal emission regime" (from 10:00PM to 06:00AM). This classification leads to a "diurnal" CO emission of 83% of daily emission.

Results are expressed as fraction of the mass of CO emitted in the CBA. In this way, results are also applicable to other inert pollutant than CO. Fractions are referred to the annual emission to allow the comparison between monthly results. The portion of annual CO emission monthly transported from the CBA to neighbouring districts is shown in Fig.3a ("diurnal emission regime"), Fig.3b ("nocturnal emission regime") and Fig.3c (total).

These results show that de la Plata River receives the largest amount of CO annual emission in the CBA. On the other hand, Avellaneda receives the smallest fraction of annual emission in the CBA. Results for Lomas de Zamora and Lanús are joined together because the border between the first one and the city is small. In Fig 3a, the two peaks observed in the CO transported to de la Plata River result mainly from the frequency of winds blowing from the city to the river. It was 33% of the "diurnal emission regime" hours in May, 26% in June and 40% in July. Fig. 3c shows that the transport of CO to Avellaneda, Lomas de Zamora-Lanús and de la Plata River is greater from May to August. The transport of CO from the CBA to the rest of the districts presents the opposite variation. Fig.4a shows the wind roses for the periods May to August and September to April. This Figure shows that the greater monthly outflows to the de la Plata River, Avellaneda and Lomas de Zamora-Lanús agree with more frequency of SW to NNE wind directions from May to August. Winds from NE-ESE sector are more frequent during September-April than during May-August. In consequence, the fraction of annual emission transported to Vicente López, San Martín and Tres de Febrero from September to April is greater than the transported during the rest of the year. As expected, most of the monthly transport of CO from the CBA to neighbouring districts takes place from 07:00AM to 09:00PM ("diurnal emission regime") (Figs. 3a and 3c).

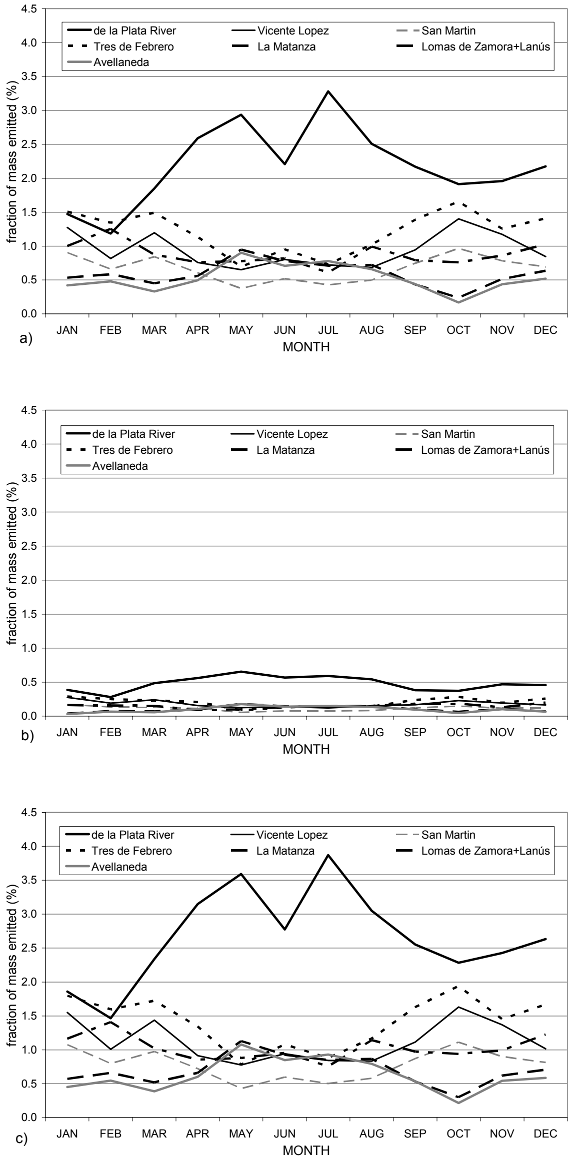

Fig. 3. Monthly variation of the fraction (%) of annual emission transported to de la Plata River and neighbouring districts. a) "diurnal emission regime", b) "nocturnal emission regime", c) total.

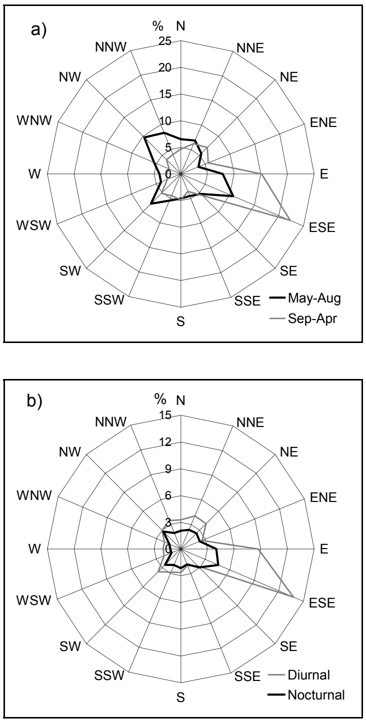

Fig. 4. a) Wind roses for the periods May-August and September-April, b) Annual "diurnal" (07:00AM – 09:00PM) and "nocturnal" (10:00PM – 06:00AM) wind roses.

The different emission rates and number of hours considered in each "emission regime" and the wind roses (Fig.4b) are the main factors conditioning results in Figs. 3a and 3b.

As can be inferred from Eq. (5) the mass of inert air pollutant transported across the border of the city per unit of time depends on the air pollutant concentration profile, the wind speed that "effectively" transports the pollutant across the border (u_n), the atmospheric stability condition and the length of the border between the city and the neighbouring district. In addition, total amount of pollutant monthly and annually transported from the CBA to neighbouring districts depend on the number of times the airflow crosses the respective border during the period. The length of the border between the CBA and each neighbouring district is (Fig. 1): de la Plata River, 18.9km; Vicente López, 4.8km; San Martín, 3.6km; Tres de Febrero, 6.4km; La Matanza, 8.5km; Lomas de Zamora-Lanús, 8.7km and Avellaneda, 7.3km. The values on Fig.3 divided by the length of the border between the CBA and each neighbouring district and by the number of hours with outflow at each boundary grid cell are shown in Fig.5a (diurnal emission regime), Fig.5b (nocturnal emission regime) and Fig.5c (total).

Monthly variations shown in Figs. 5a, 5b, and 5c are different from the included in Figs.3a, 3b and 3c. Two groups (% km^{-1} $times^{-1}$) can be distinguished: a) higher values associated with the CO transported to San Martín, Vicente López and Tres de Febrero (to the NW and W of the city) (see Fig.1) and b) lower values associated with the CO transported to the de la Plata River, Avellaneda, Lomas de Zamora-Lanús and La Matanza.

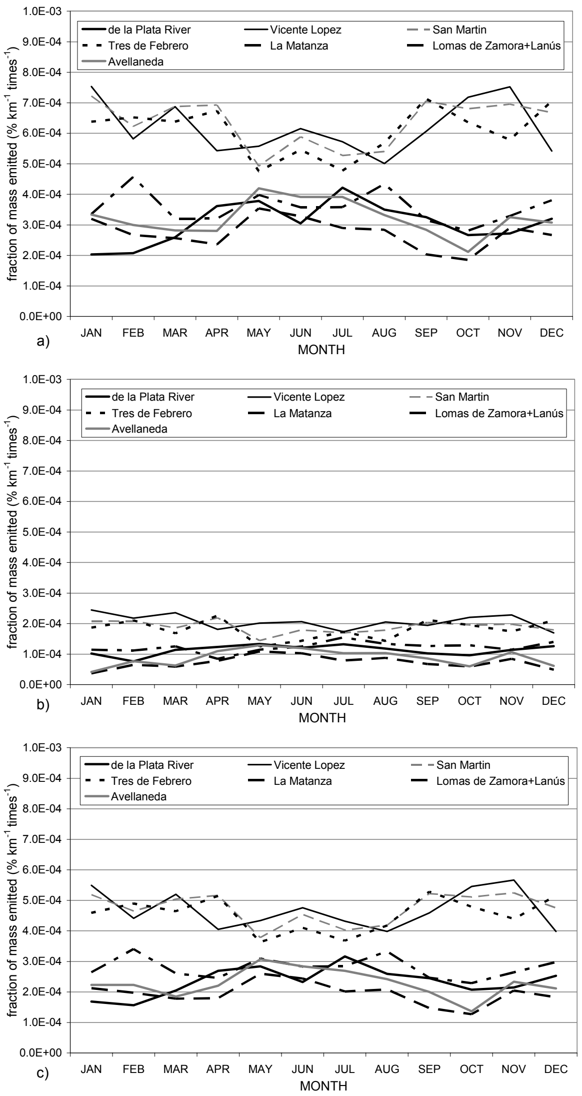

Fig. 5. Monthly variation of annual emission fraction transported to de la Plata River and MABA districts expressed by unit of border length and outflow times (% km^{-1} times^{-1}). a) “diurnal emission regime”, b) “nocturnal emission regime” c) total.

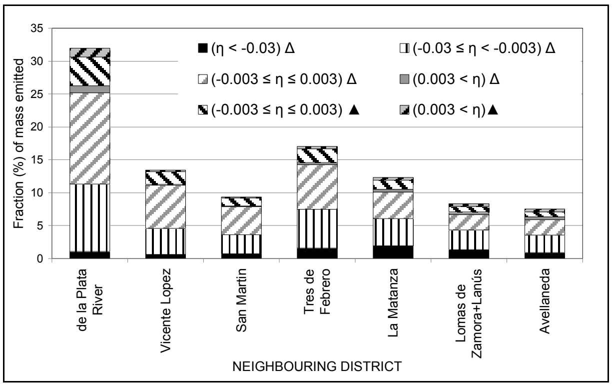

Fig. 6. Fraction (%) of CO emitted in the City of Buenos Aires annually transported to neighbouring districts. Ranges of η= z_0/L are indicated. Δ “diurnal emission regime” (07:00AM – 09:00PM). ▲ “nocturnal emission regime” (10:00PM – 06:00AM)

These results agree with the characteristics of the wind roses shown in Fig.4a.

Figure 6 illustrates the fraction (%) of CO emitted in the City of Buenos Aires annually transported to neighbouring districts and the de la Plata River. This figure shows the CO transported during diurnal and nocturnal emission regimes and different atmospheric stabilities (η= z_0/L).

The largest portion (32%) of the CO annually emitted in the CBA goes to the de la Plata River. The smallest fraction (7.5% of annual emission) is transported South, to the district of Avellaneda. Considering all districts, 52% of CO annual emission is exported to neighbouring areas during near neutral ($-0.003 \leq \eta \leq 0.003$) atmospheric conditions. Most of the times, moderate to high winds are observed in these situations. On the other hand, a very small fraction is transported from the city to neighbouring areas in very unstable conditions ($\eta < -0.03$). In a very unstable atmosphere, vertical motions are enhanced by buoyancy and pollutants are mixed rapidly. Low winds are registered in these atmospheric conditions.

The large amount of CO transported from the CBA to the de la Plata River is mainly the result of the large border between them. It is about 2 to 4 times larger than the border between the city and other neighbouring districts. In addition, the annual number of hours with “effective transport” from the city to the river is 1.2 to 1.5 times the number of hours with “effective transport” from the city to the other neighbouring districts. Furthermore, considering CO emissions in the city, DAUMOD estimated annual mean background concentrations at ground level at the border of the city resulted: at de la Plata River: 1.20 mg m^{-3}; at Vicente López: 0.88 mg m^{-3}; at San Martín: 0.65 mg m^{-3}; at Tres de Febrero: 0.70 mg m^{-3}; at La Matanza: 0.48 mg m^{-3}; at Lomas de Zamora-Lanús: 0.75 mg m^{-3} and at Avellaneda: 0.75 mg m^{-3}.

III. BACKGROUND CO CONCENTRATIONS IN THE MABA DUE TO THE EMISSIONS IN THE CITY OF BUENOS AIRES

Previous results show that 2/3 of CO annual emission in the CBA can be transported from the city to neighbouring urban districts. The interest is to evaluate the possible contribution of area source emissions in the CBA to background CO concentrations in the MABA.

A. Methodology- Brief description

The urban atmospheric dispersion model DAUMOD (Mazzeo and Venegas, 1991; Venegas and Mazzeo, 2006a, 2006b) is applied to estimate ground level background CO concentrations in the MABA due to the CO emitted in the CBA. The model is run considering the CO emissions inventory for the City of Buenos Aires, one year of hourly meteorological data and a spatial resolution of 1x1km. Then, spatial distributions of 8h CO background concentrations (C_{8h}) in the MABA due to the CO emitted in the CBA are estimated.

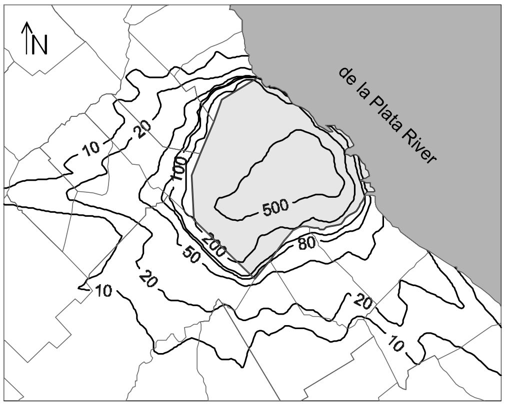

Fig. 7. Isopleths of absolute annual frequency of 8h CO background concentrations greater than 1 mg m^{-3}.

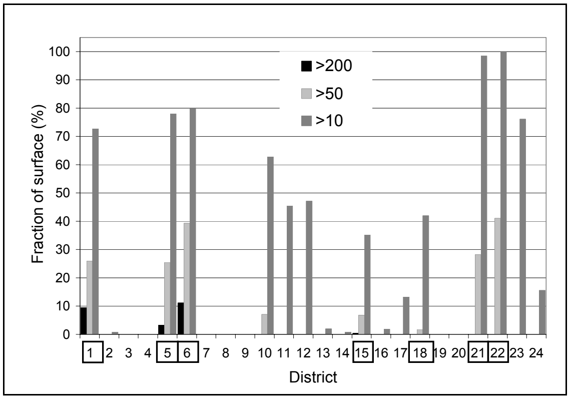

Fig. 8. Fraction (%) of district surface where C_{8h}>1mg m^{-3} during > 200, > 50 and > 10 cases $year^{-1}$. (the number of the district is shown in Fig. 1). Marked districts limit with the City of Buenos Aires

B. Results

The Air Quality Standard (AQS) for CO in the MABA is 10 mg m^{-3} (for 8h averaging time). In order to illustrate the magnitude of the estimated background concentrations, the isopleths of absolute annual frequency of C_{8h} >1mg m^{-3} (10% the AQS) are shown in Fig. 7.

It can be seen that the contribution of the CO emitted in the CBA to 8h CO background concentrations can be greater than 1mg m^{-3} more than 200 cases $year^{-1}$ in Vicente López, San Martín and Tres de Febrero, located to NW-W of the CBA. This result agrees with the high frequency of wind directions from the E-SE sector shown in Fig.4.

The percentage (%) of the district surface where C_{8h}>1 mg m^{-3} more than a given number of cases per year (>200, >50, >10 cases $year^{-1}$) is shown in Fig. 8.

IV. CONCLUSIONS

The fraction of CO emitted in the City of Buenos Aires (CBA) transported to neighbouring districts of the MABA and to the de la Plata River is estimated. To achieve this task analytical expressions have been developed using the expressions of an urban atmospheric dispersion model. The methodology is applicable to inert air pollutants. Annual emission of CO in the City of Buenos Aires is exported in the following way: 32.0% to the de la Plata River, 17.1% to Tres de Febrero, 13.4% to Vicente López, 12.3% to La Matanza, 9.4% to San Martín, 8.3% to Lomas de Zamora+Lanús and 7.5% to Avellaneda. An important portion of the CO annual emission is transported from the CBA to neighbouring districts during near neutral atmospheric conditions. The large extension of the border between the de la Plata River and the CBA is one of the main factors in determining the amount of air pollutant transported to the river. In addition, the annual number of hours with effective transport from the CBA to the river is 1.2 to 1.5 times those to the neighbouring districts. Results divided by the length of the border and the number of hours with effective transport across it, expressed as (% km^{-1} $times^{-1}$) show higher values to San Martín, Vicente López and Tres de Febrero.

The CO emissions in the City of Buenos Aires may contribute to 8h CO background concentrations at the neighbouring districts with more than 10% of the AQS. The districts located N, NW and W the CBA are the most affected by the emissions in the city.

ACKNOWLEDGEMENTS

This work has been partially supported by Grant CONICET PIP6169. The authors wish to thank the National Meteorological Service of Argentina for providing meteorological data used in this work.

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