GF3022 2011/2- Auxiliar Emisiones

Emisiones

Fuentes

Fijas (Estacionarias)

Puntuales — *eg. Fundición, Industria,..*

Área — *eg. Quema de biomasa,..*

Móviles

Fuentes Móviles

¿Que? CO, NO, NO_2, HC, SO_2, PM, VOC….

¿Como? A partir de Hidrocarburos, por motores de combustión interna

Gasolina

Diesel

CO: Combustión completa

Gasolina

Hidrocarburos: C_aH_b

Aire

$$C_aH_b + \left(a + \frac{b}{4}\right)(O_2 + 3.773N_2) = aCO_2 + \frac{b}{2}H_2O + 3.773\left(a + \frac{b}{4}\right)N_2$$

Relación estequiométrica: Reactantes = productos

En una combustión “perfecta” no se deberia producir CO!

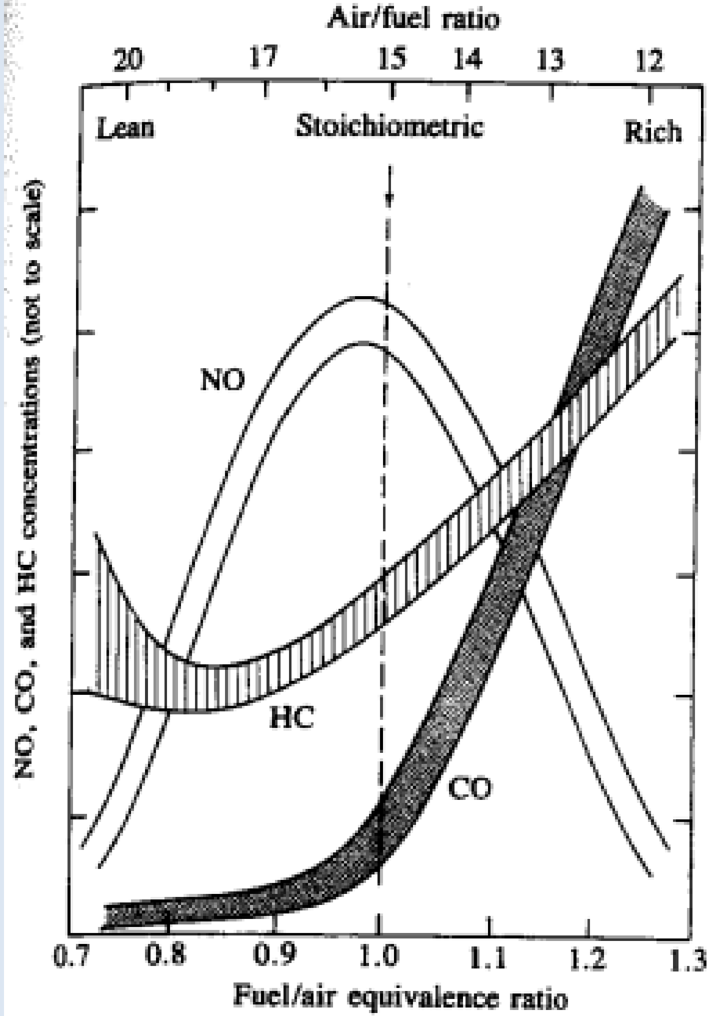
A: aire
F: Combustible
y=b/a

$$\left(\frac{A}{F}\right)_s = \left(\frac{F}{A}\right)_s^{-1} = \frac{(1 + y/4)(32 + 3.773 \times 28.16)}{12.011 + 1.008y} = \frac{34.56(4 + y)}{12.011 + 1.008y}$$

En realidad …

Heywood, 1988

Combustión *in*completa



$$\phi = \frac{(F/A)_{actual}}{(F/A)_s}$$

Comb, Incompleta: No se oxidan los HC . Se produce CO

FIGURE 11-2
Variation of HC, CO, and NO concentration in the exhaust of a conventional spark-ignition engine with fuel/air equivalence ratio.

Heywood, 1988

NOx

$$O + N_2 = NO + N \qquad (11.1)$$

$$N + O_2 = NO + O \qquad (11.2)$$

$$N + OH = NO + H \qquad (11.3)$$

† This is often called the extended Zeldovich mechanism. Zeldovich[1] was the first to suggest the importance of reactions (11.1) and (11.2). Lavoie *et al.*[2] added reaction (11.3) to the mechanism; it does contribute significantly.

Se necesita de mucha enegía para 11.1 y 11.2 !!!

Heywood, 1988

NOx

11.1

11.2

TABLE 11.1
Rate constants for NO formation mechanism[1]

Reaction	Rate constant, $cm^3/mol \cdot s$	Temperature range, K	Uncertainty, factor of or %
(1) $O + N_2 \rightarrow NO + N$	$7.6 \times 10^{13} \exp[-38{,}000/T]$	2000–5000	2
(−1) $N + NO \rightarrow N_2 + O$	1.6×10^{13}	300–5000	±20% at 300 K 2 at 2000–5000 K
(2) $N + O_2 \rightarrow NO + O$	$6.4 \times 10^{9}\, T \exp[-3150/T]$	300–3000	±30% 300–1500 K 2 at 3000 K
(−2) $O + NO \rightarrow O_2 + N$	$1.5 \times 10^{9}\, T \exp[-19{,}500/T]$	1000–3000	±30% at 1000 K 2 at 3000 K
(3) $N + OH \rightarrow NO + H$	4.1×10^{13}	300–2500	±80%
(−3) $H + NO \rightarrow OH + N$	$2.0 \times 10^{14} \exp[-23{,}650/T]$	2200–4500	2

Diesel: Altas temperaturas + mucho oxígeno +

Enfriamiento rápido

Heywood, 1988

Inventarios de Emisiones

Cuanto, donde, que se emite, fuentes…

Ejemplo: Emisiones vehiculares

$$E_{i,j,k} = N_j \times VKT_{j,k} \times EF_{i,j,k} \qquad (1)$$

where, $E_{i,j,k}$: emissions of species i, vehicle category j, road type k, thermally stabilized engine; N_j: number of circulating vehicles, category j; $VKT_{j,k}$: kilometers traveled, vehicle category j, road type k; $EF_{i,j,k}$: hot emission factor, species i, vehicle category j, road type k.

D'Angiola et al, 2010

$$E_{h,i,j,k} = F_j\, L_j\, EF_{i,k}(v)\, FP_j\, C_{j,k} \qquad (1)$$

where $E_{h,i,j,k}$ is the emission of pollutant i during the hour of the day h on the arc of the traffic network j from vehicle category k expressed in grams per hour; F_j is the total traffic volume at the arc j on-peak traffic hours expressed in vehicles per hour; L_j is the total length of the arc j in kilometers; $EF_{i,k}(v)$ is the emission factor of pollutant i and vehicle category k as a function of average speed v in grams per kilometer-vehicle; FP_j is the hourly traffic flow profile at the arc j for different day types; and $C_{j,k}$ is the fraction of the total traffic volume corresponding to the vehicle category k on the arc j.

Como no se puede medir TODAS las fuentes TODO el tiempo se estima..

Corvalán et al, 2002

Cada vehículo emite diferente ….- → clasificación de vehículos

Bs. As.

Category	Vehicle type	Fuel	Emissions control	Period of registration	VKT	Fleet (2006)	Source of information	Classification Characteristics
PC1	Passenger Cars	Gasoline	No	≤1996	7000	913,768	DNRPA	Vehicles of less than 2.5 ton with an engine size of 1.4–2.0 L that are employed by private owners for their own travel needs.
PC2	Passenger Cars	Gasoline	No	1997–2000	7700	272,247		
PC3	Passenger Cars	Gasoline	Yes	2001–2003	8470	222,503		
PC4	Passenger Cars	Gasoline	Yes	2004–2006	9300	62,244		
PC5	Passenger Cars	Diesel oil	No	≤2000	20,000	170,826		
PC6	Passenger Cars	Diesel oil	Yes	2001–2003	22,000	81,822		
PC7	Passenger Cars	Diesel oil	Yes	2004–2006	24,200	10,695		
PC8	Passenger Cars	CNG	No	≤2000	29,000	158,141	ENARGAS	
PC9	Passenger Cars	CNG	Yes	2001–2006	31,900	115,187		
TX1	Taxicabs	Diesel oil	No	≤2000	60,000	19,648	GCBA	Vehicles of less than 2.5 ton with an engine size of 1.4–2.0 L that are employed for passengers public transport. They were differentiated from PC as they meet different travel demands (higher VKT).
TX2	Taxicabs	Diesel oil	Yes	2001–2003	60,000	6534		
TX3	Taxicabs	Diesel oil	Yes	2004–2006	60,000	1586		
TX4	Taxicabs	CNG	No	≤2000	60,000	5071		
TX5	Taxicabs	CNG	Yes	2001–2006	60,000	5559		
SUV1	Sport Utility Vehicles	Gasoline	No	≤1996	7000	56,542	DNRPA	Vehicles of less than 2.5 ton with an engine size $>$ 2.0 L that are employed by private owners for their own travel needs.
SUV2	Sport Utility Vehicles	Gasoline	No	1997–2000	7700	15,162		
SUV3	Sport Utility Vehicles	Gasoline	Yes	2001–2003	8470	12,204		
SUV4	Sport Utility Vehicles	Gasoline	Yes	2004–2006	9300	544		
SUV5	Sport Utility Vehicles	Diesel oil	No	≤2000	20,000	85,517		
SUV6	Sport Utility Vehicles	Diesel oil	Yes	2001–2003	22,000	22,647		
SUV7	Sport Utility Vehicles	Diesel oil	Yes	2004–2006	24,200	795		
SUV8	Sport Utility Vehicles	CNG	No	≤2000	29,000	20,363	ENARGAS	
SUV9	Sport Utility Vehicles	CNG	Yes	2001–2006	31,900	11,698		
LDT1	Light-Duty Trucks	Gasoline	No	≤2000	18,000	31,603	DNRPA	Vehicles of less than 3.5 ton with an engine size $<$ 2.0 L that are employed for the local transport of goods. They were differentiated from SUV as they meet different travel demands (higher VKT).
LDT2	Light-Duty Trucks	Gasoline	Yes	2001–2003	19,800	4545		
LDT3	Light-Duty Trucks	Gasoline	Yes	2004–2006	21,780	357		
LDT4	Light-Duty Trucks	Diesel oil	No	≤2000	55,000	42,471		
LDT5	Light-Duty Trucks	Diesel oil	Yes	2001–2003	60,500	20,292		
LDT6	Light-Duty Trucks	Diesel oil	Yes	2004–2006	66,550	556		
LDT7	Light-Duty Trucks	CNG	No	≤2000	67,500	5989	ENARGAS	
LDT8	Light-Duty Trucks	CNG	Yes	2001–2006	74,250	10,952		
HDT1	Heavy-Duty Trucks	Diesel oil	No	≤2000	75,000	24,486	CNRT	Vehicles of weight $>$3.5 ton that travel long distances for the transport of goods at provincial, national or international levels.
HDT2	Heavy-Duty Trucks	Diesel oil	Yes	2001–2006	82,500	5798		
B	Buses	Diesel oil	Yes	≤2006	80,000	9654		Urban public buses that travel around the metropolitan area of Buenos Aires
C	Coaches	Diesel oil	Yes	≤2006	13,500	10,560		Interurban buses that travel throughout the national territory
						2,438,569		

D’Angiola et al, 2010

Campaña de Medición + características locales+ Experiencia → Factores de emisión

(Cómo se conduce, Combustible, mantenimiento vehículos,..)

Table 3
Emission factors (g km^{-1}) by category employed in this study. Regionally measured EFs are reported on the basis of the median values and accompanied with the lower and upper quartile values in brackets. Uncertainty ranges are not reported for those EFs obtained from international sources (COPERT IV and IPCC emission factors database); for the criteria adopted for these cases, see Section 2.5.

ID	Fuel	CO_2	CH_4	N_2O	CO	NMVOCs	NO_X	PM	SO_2
PC1	G	299	0.184	0.013	53.51 (29.10–88.08)	4.87 (1.28–8.24)	1.43 (0.82–2.12)	0.024	0.1136
PC2	G	299	0.184	0.013	17.23 (9.42–36.66)	1.78 (0.87–2.86)	0.87 (0.39–1.44)	0.024	0.1136
PC3	G	213	0.038	0.032	20.46 (13.74–33.14)	1.55 (0.42–3.42)	1.16 (0.61–1.74)	0.024	0.0810
PC4	G	213	0.043	0.017	2.58 (1.31–23.64)	0.21 (0.02–0.54)	0.19 (0.06–0.98)	0.024	0.0810
PC5	D	213	0.034	0.000	0.82	0.18	0.58	0.306	0.2016
PC6	D	182	0.016	0.002	0.55	0.06	0.67	0.099	0.1720
PC7	D	182	0.009	0.005	0.46	0.04	0.73	0.086	0.1720
PC8	CNG	236	0.709	0.068	6.36 (2.00–18.23)	1.56 (0.24–2.79)	1.74 (1.05–3.70)	0.021	0.0002
PC9	CNG	168	0.709	0.068	6.36 (2.00–18.23)	1.56 (0.24–2.79)	1.74 (1.05–3.70)	0.021	0.0001
TX1	D	213	0.033	0.000	0.82	0.18	0.58	0.306	0.2016
TX2	D	182	0.015	0.002	0.55	0.06	0.67	0.099	0.1720
TX3	D	182	0.008	0.004	0.46	0.04	0.73	0.086	0.1720
TX4	CNG	236	0.709	0.068	6.36 (2.00–18.23)	1.56 (0.24–2.79)	1.74 (1.05–3.70)	0.021	0.0002
TX5	CNG	168	0.709	0.068	6.36 (2.00–18.23)	1.56 (0.24–2.79)	1.74 (1.05–3.70)	0.021	0.0001
SUV1	G	367	0.184	0.013	81.47 (27.46–146.58)	8.74 (5.03–13.16)	2.62 (1.43–3.73)	0.024	0.1392
SUV2	G	367	0.184	0.013	14.84 (9.94–33.14)	1.79 (1.50–6.56)	0.99 (0.65–3.32)	0.024	0.1392
SUV3	G	286	0.038	0.032	15.44 (6.81–22.85)	1.06 (0.28–1.77)	0.94 (0.29–1.59)	0.024	0.1085
SUV4	G	285	0.043	0.017	7.36 (3.21–23.19)	0.44 (0.17–0.70)	0.46 (0.21–0.80)	0.024	0.1082
SUV5	D	213	0.034	0.000	0.82	0.18	0.90	0.306	0.2016
SUV6	D	234	0.016	0.002	0.55	0.10	0.67	0.099	0.2209
SUV7	D	234	0.009	0.005	0.46	0.14	0.73	0.086	0.2209
SUV8	CNG	289	0.709	0.068	10.81 (4.03–19.67)	1.56 (0.24–2.79)	2.51 (1.46–3.92)	0.021	0.0002
SUV9	CNG	225	0.709	0.068	10.81 (4.03–19.67)	1.56 (0.24–2.79)	2.51 (1.46–3.92)	0.021	0.0002
LDT1	G	365	0.184	0.013	33.33 (20.90–53.29)	4.38 (2.85–7.23)	1.23 (0.92–1.43)	0.032	0.1387
LDT2	G	365	0.038	0.044	26.4 (22.89–32.79)	3.07 (0.09–8.07)	1.61 (0.62–2.41)	0.032	0.1387
LDT3	G	365	0.043	0.036	22.48 (19.49–27.92)	2.19 (0.05–5.78)	1.49 (0.58–2.24)	0.032	0.1387
LDT4	D	279	0.034	0.000	1.37	0.15	2.05	0.396	0.2638
LDT5	D	252	0.016	0.002	0.51	0.17	1.26	0.129	0.2378
LDT6	D	252	0.009	0.005	0.51	0.17	1.26	0.129	0.2378
LDT7	CNG	288	0.709	0.068	1.6 (0.60–4.60)	0.09 (/–0.64)	1.85 (0.75–3.50)	0.029	0.0002
LDT8	CNG	288	0.709	0.068	1.6 (0.60–4.60)	0.09 (/–0.64)	1.85 (0.75–3.50)	0.029	0.0002
HDT1	D	837	0.171	0.029	3.88 (2.11–7.13)	3.52 (1.98–8.10)	8.92 (4.37–12.14)	1.151 (0.527–1.977)	0.7906
HDT2	D	837	0.171	0.011	1.83 (1.11–5.84)	0.52 (0.35–1.18)	5.61 (3.50–8.37)	0.267 (0.160–0.583)	0.7906
B	D	771	0.111	0.012	6.09 (4.66–11.02)	1.32 (0.93–1.72)	15.98 (12.98–18.59)	0.287 (0.187–0.570)	0.7283
C	D	893	0.111	0.011	6.09 (4.66–11.02)	1.32 (0.93–1.72)	15.98 (12.98–18.59)	0.287 (0.187–0.570)	0.8437

D’Angiola et al, 2010

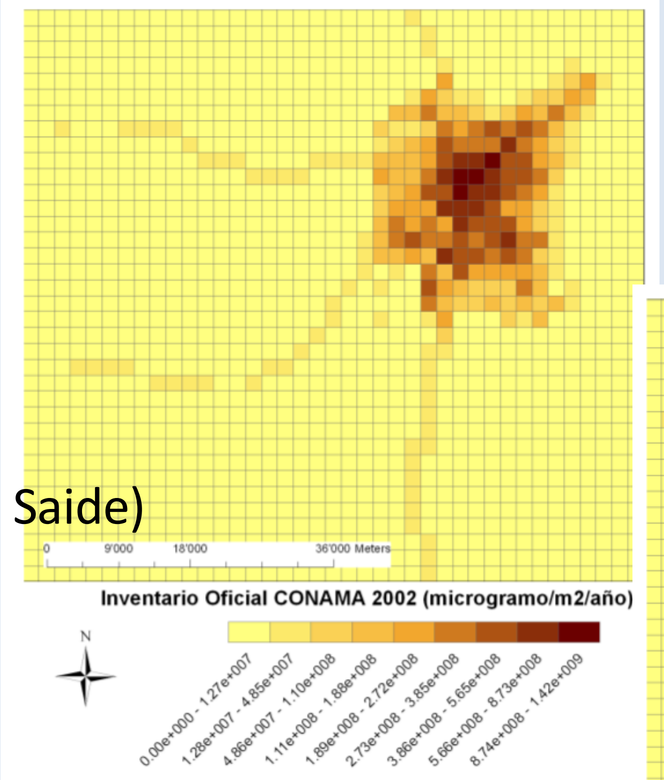
Extrapolación: Actividad, cantidad, población,…..

Fig. 6. Emissions in Gg of CO^2, CH^4, N^2O, CO, NMVOCs, NO^X, PM and SO^2 disaggregated by district of the metropolitan area of Buenos Aires (2006).

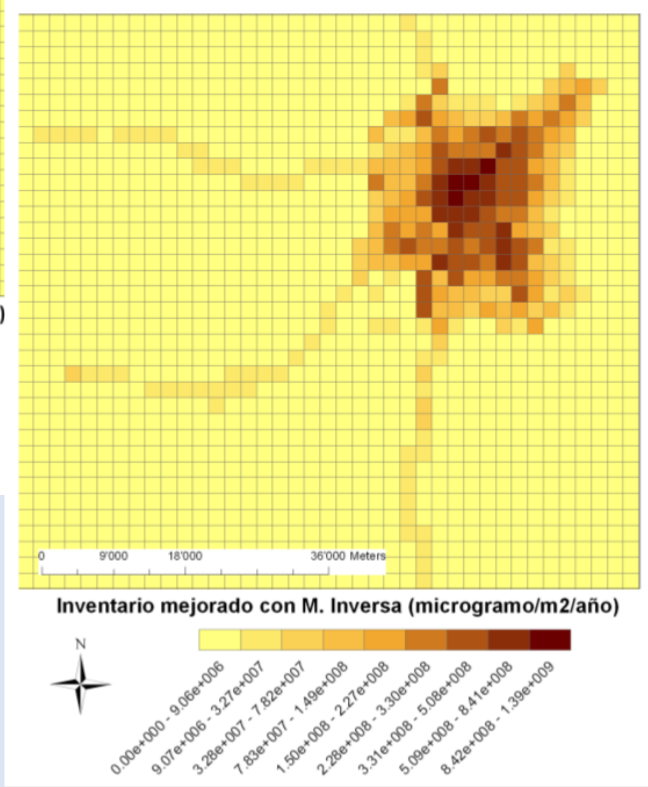
D'Angiola et al, 2010

Evaluación de Inventarios

- Con otros inventarios…



- Métodos Inversos.. (eg. P. Saide)



- Satelites / Observaciones…

P. Saide, 2007

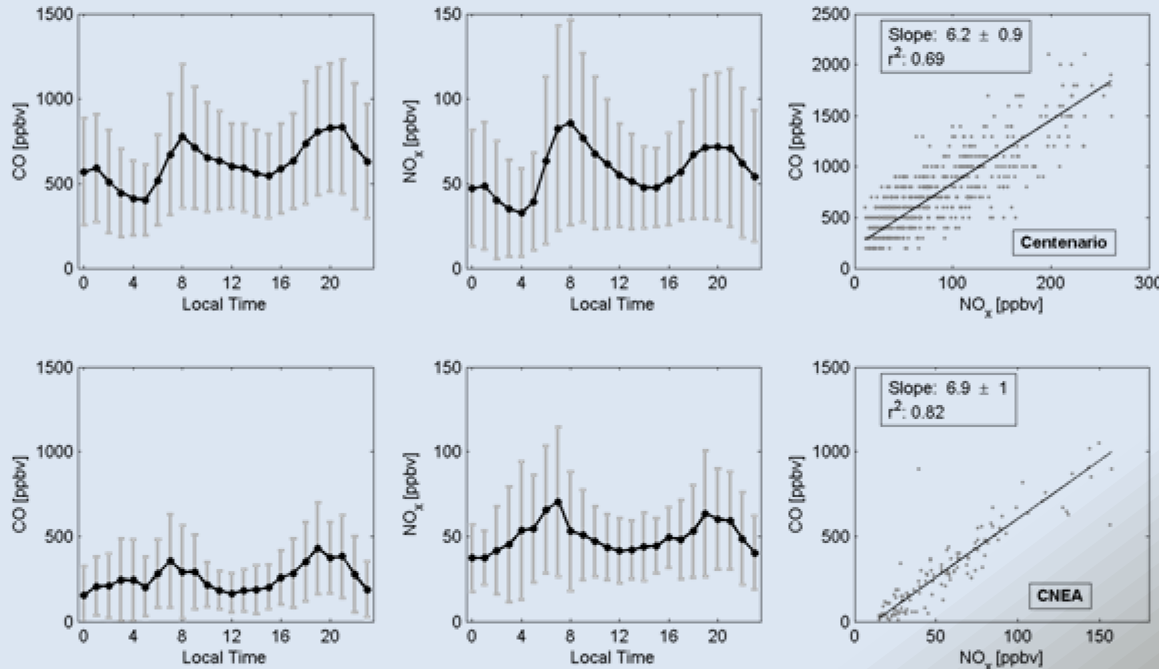
Evaluación de Inventario: CO-NO_X

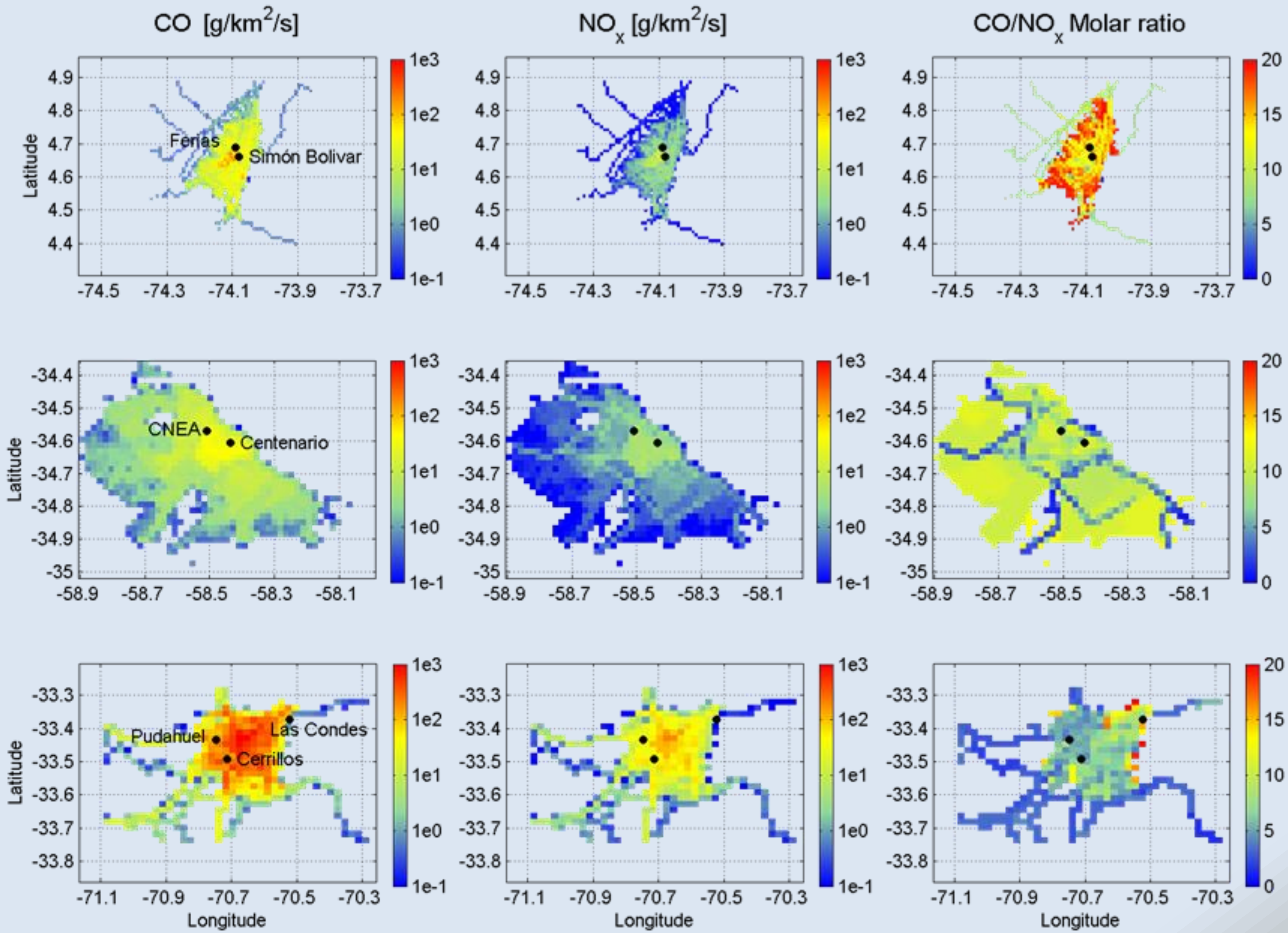
Gallardo et all, 2011 (en revisión)

Comparación de Inventarios de CO y NOx (NOx = NO_2 + NO) utilizando **observaciones matutinas**

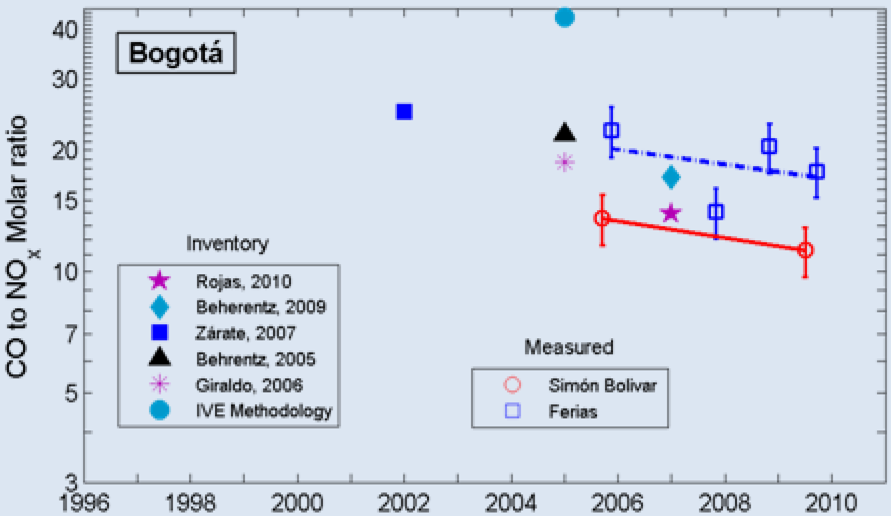
- Hora punta: Altas concentraciones de CO y NOx

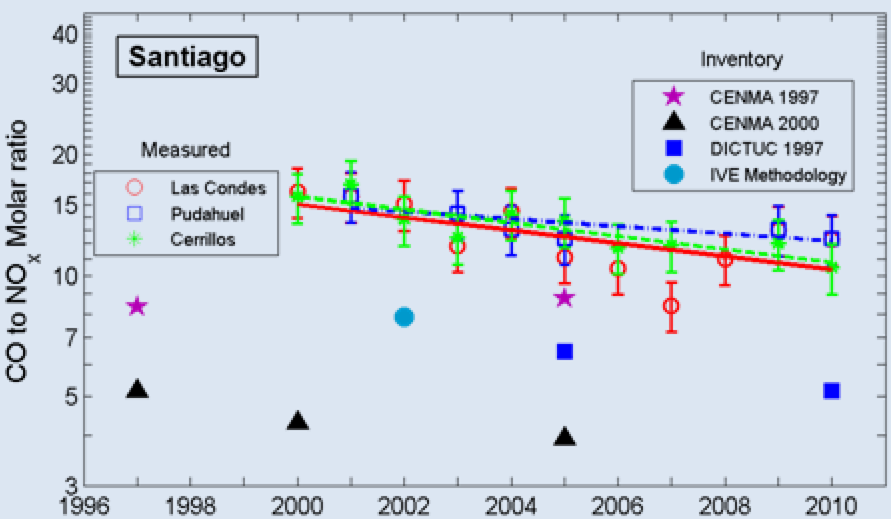
- Capa limite poco profunda: Emisiones concentradas cerca de la superficie y “frescas”





CO [g/km2/s]
NOx [g/km2/s]
CO/NOx Molar ratio
Latitude
Longitude
Ferias
Simón Bolivar
CNEA
Centenario
Pudahuel
Las Condes
Cerrillos
1e3
1e2
1e1
1e0
1e-1
20
15
10
5
0

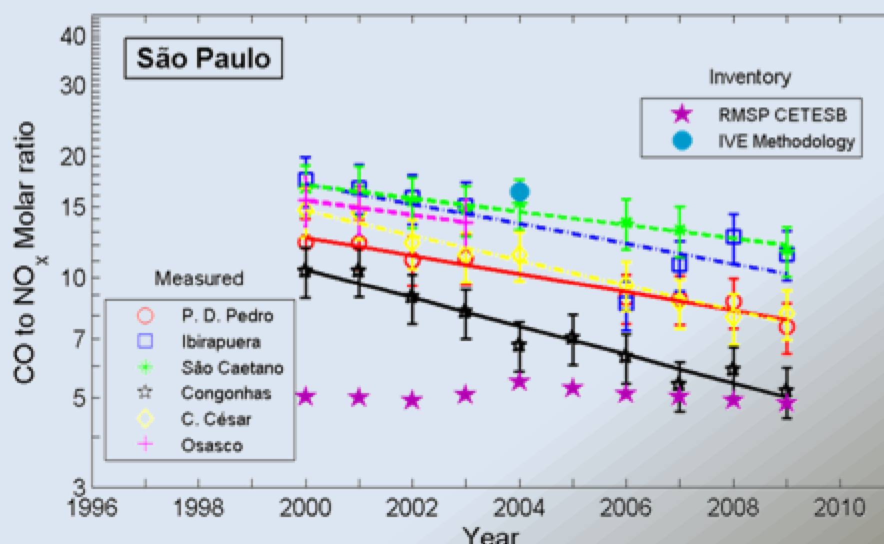


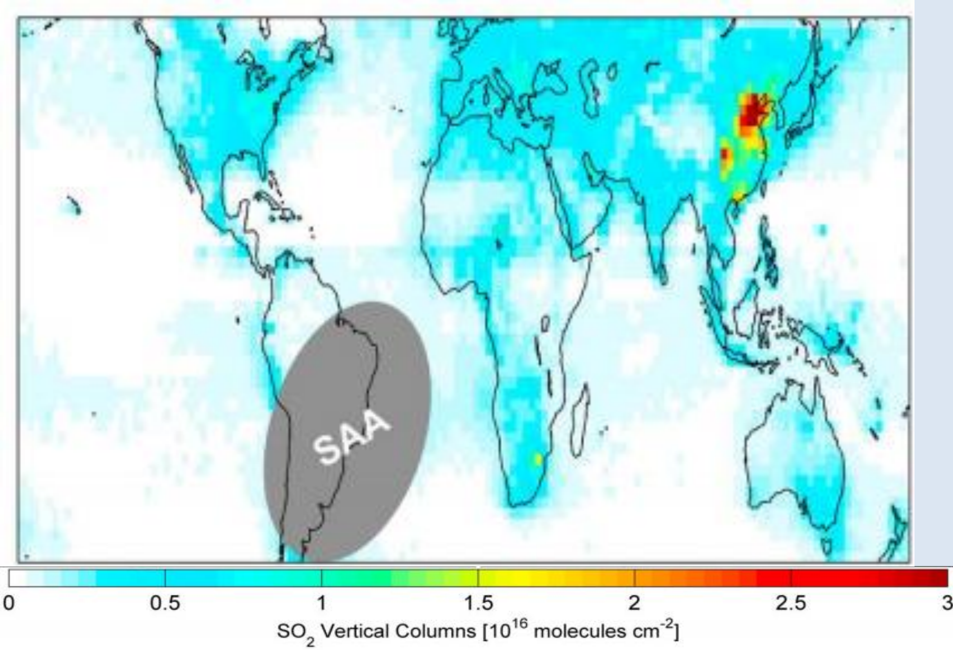


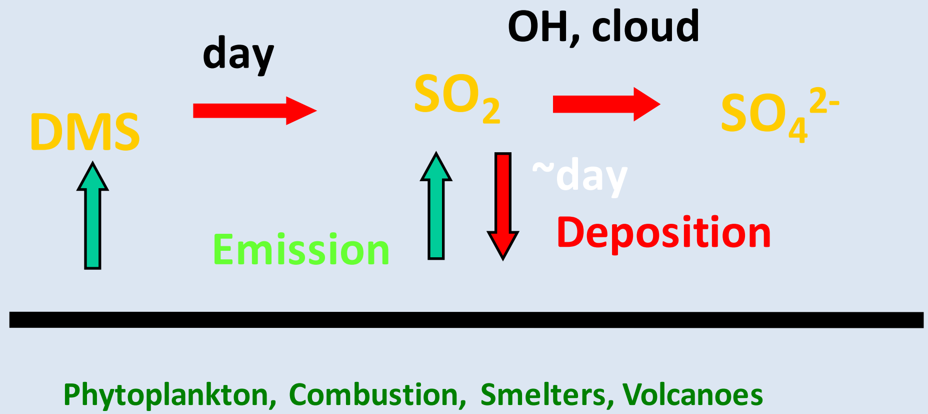
Santiago:

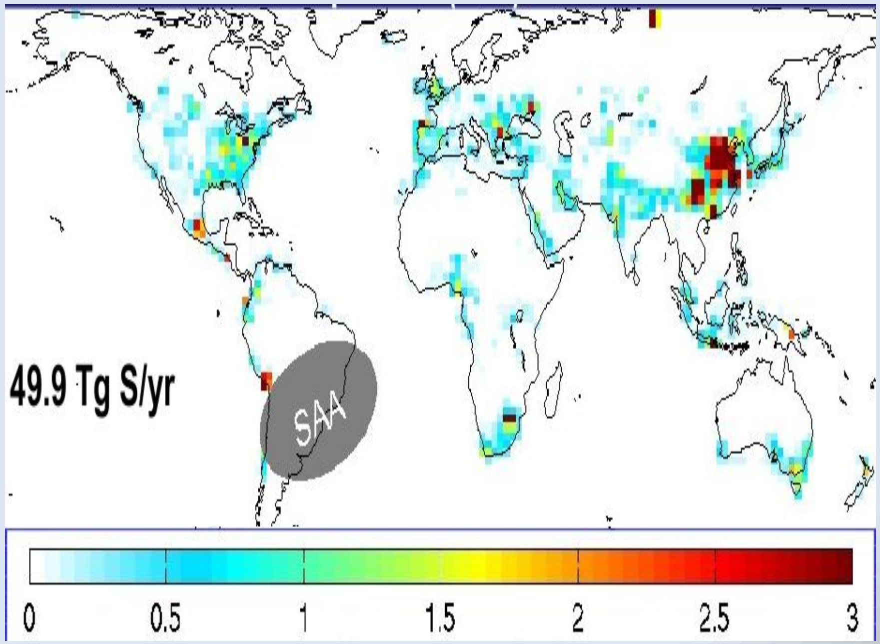
Diminución de CO/NOx por disminución de CO..

NOx es más difícil de estimar en inventarios (más dependencia de V): Sobreestimación de NOx en factor 3









SO2 Emissions (1e11 molec cm-2s-1)

$$E_t = \frac{\Omega_{SO2}(OMI)}{\tau_{SO2}(GEOS - Chem)}$$

Lee et al., 2011, Martin et al., 2003