8.VERT-Forum, 17.März 2017, EMPA-Academy Dübendorf

# VERT DPF Retrofit Projects and Clean Air Policies In Latin America

Andreas C.R. Mayer

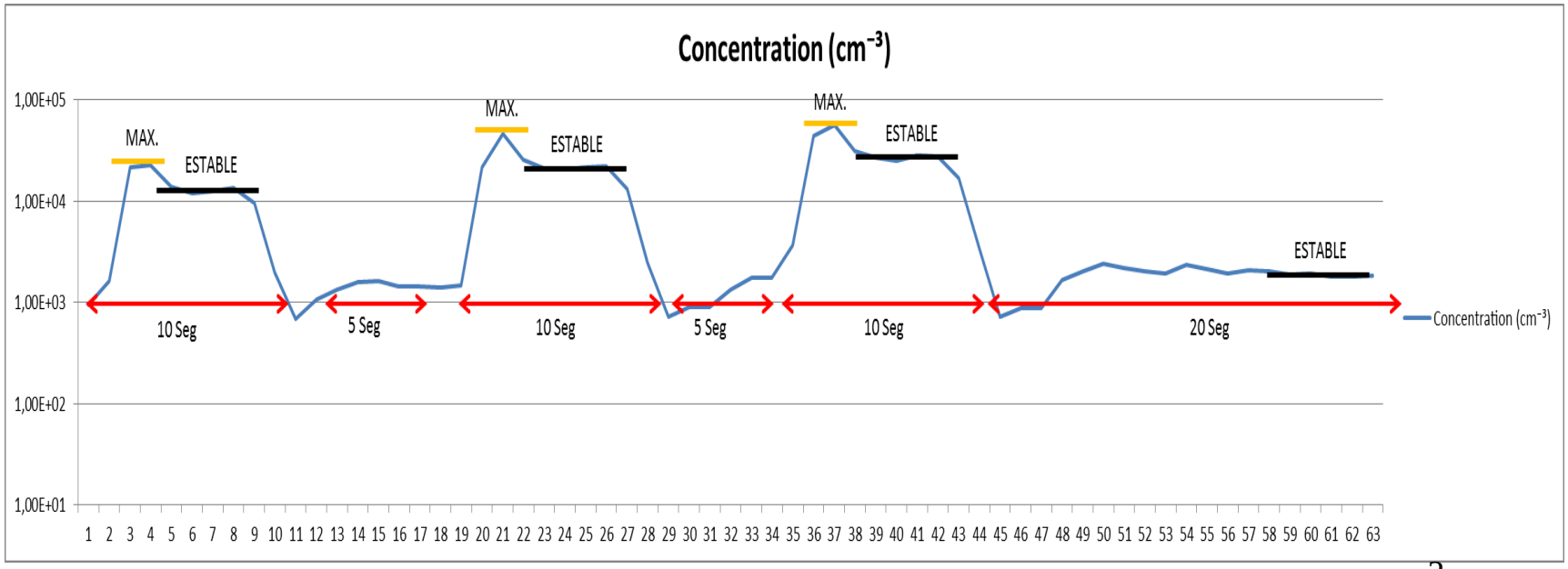
# Santiago de Chile

## Retrofit Pilot 2005 – now 3’500 public transport buses

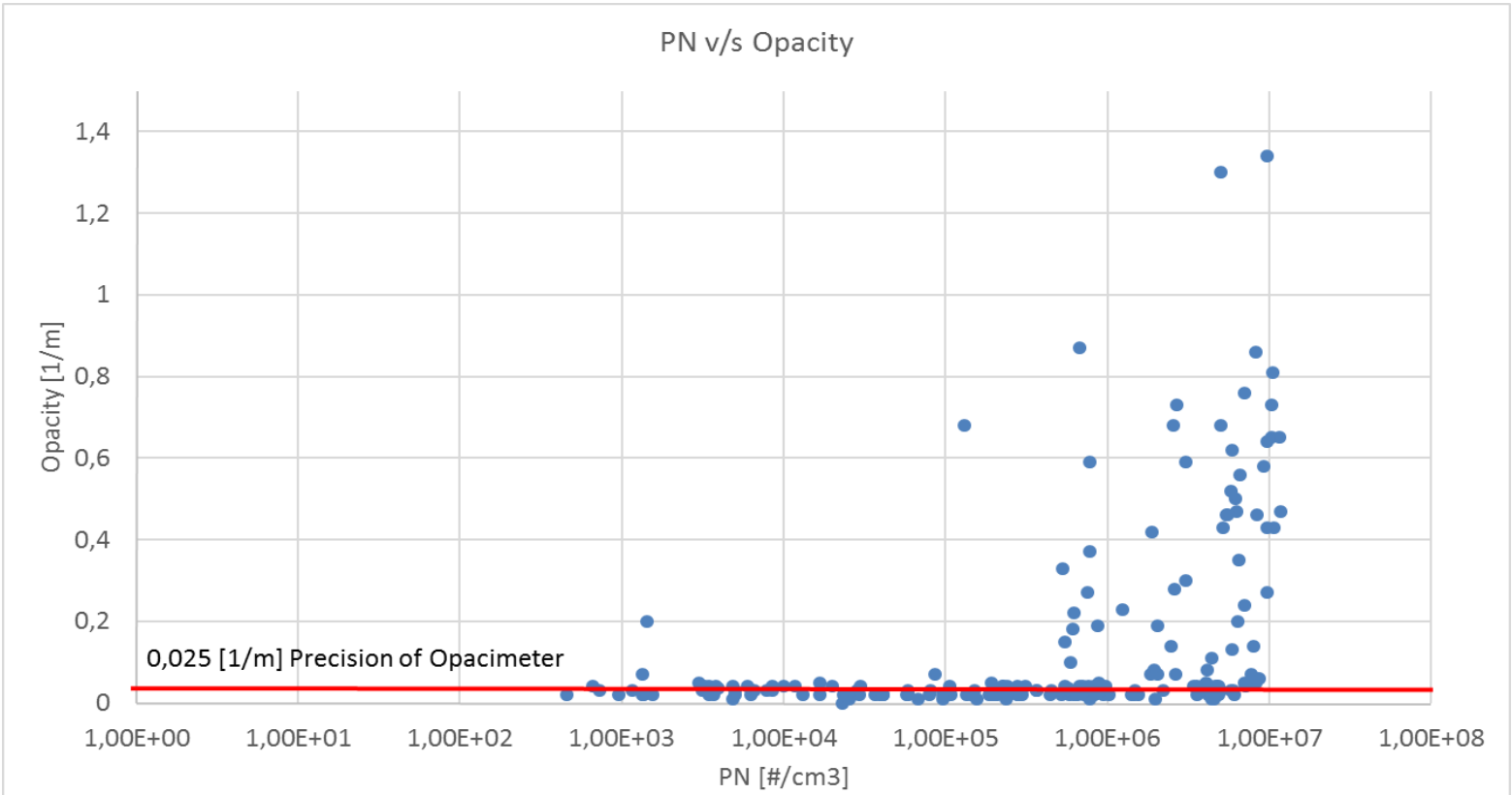
- Santiago has decided to abandon Euro V and to switch to Euro VI (imported directly from Europe)
- Ministry for Public Works has started to retrofit construction machines with DPF – for the Metropolitan area + stage 5
- The high number of DPF buses requires professional DPF-cleaning – a private company using FSX-technology
- LEZ-plan: will also require trucks circulating into the city center to have DPF
- DPF for gensets (>10’000): regulation reviewed but introduction delayed
- Santiago will introduce NPTI within next 24 month as a regulation based on Particle Number PN evaluation by A.Reinoso 2015
- The oldest fleet (2009) must exchange many filters, detected by PN control to have failed.

# Breakthrough by new Measurement Protocol

- Roadside: Opacity and PN (NPET) at end of pipe during free acceleration, high idle and low idle.
- In-Depot: upstream and downstream to calculate filtration efficiency



# Comparison PN v/s Opacity at Free Acceleration




- 30% of opacity results were close to 0 [1/m] (or below 0.025 [1/m]) but with results between 10E+2 to 10E+9 [#/cm3] in PN (including W/DPF and WO/DPF).

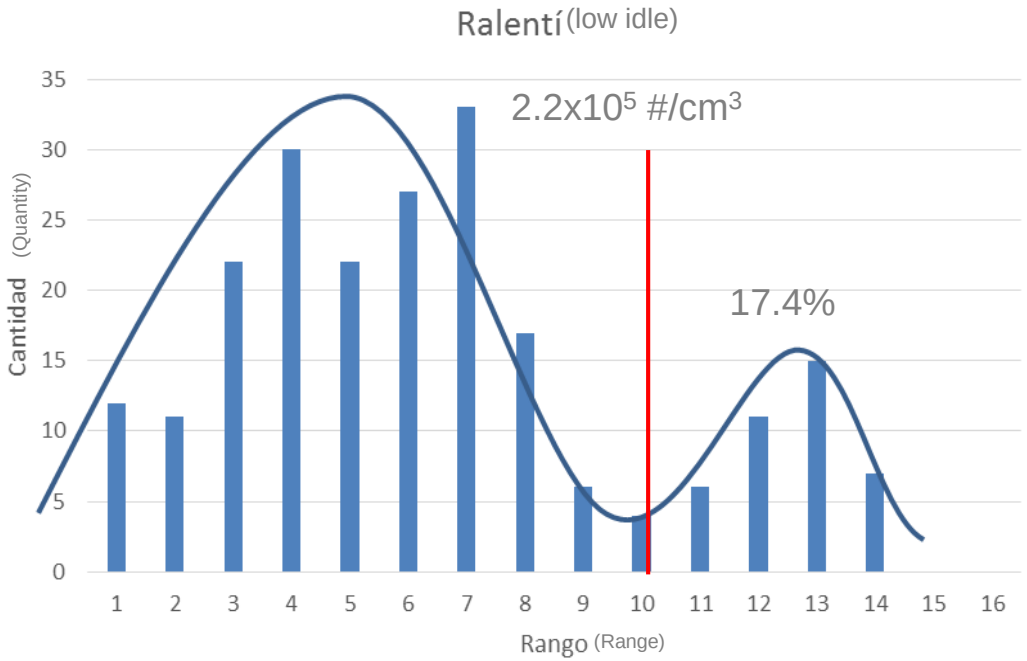
# Fleet summary considering proposed threshold

| Implementation Stage | Number of Abnormal Emissions | Buses Tested | Rate of Abnormal Emissions | Average DPF Milage [km] |
|---|---|---|---|---|
| 2005-2009 | 21 | 25 | 84% | 524,341 |
| 2010-2013 | 18 | 198 | 9% | 297,084 |
| Total | 39 | 223 | 17,5% | 325,920 |

- Abnormal emissions are concentrated in early stage of implementation (more mileage DPF, wo/pressure monitoring, weak local support, best practices for engine and DPF maintenance not implemented yet).
- Complementary specific efficiency test are necessary to discard high gross engine emitters like the cause.
- Considering >95% of efficiency, gross engine emissions had to be > $4.4x10^6$ , in order to exceed the threshold.
- Few cases of gross engine emissions > $4.4x10^6$ were detected in same kind of buses measured without DPF (3%).

# Develop Pass/Fail Criterion

- Binned bus measurements into log-spaced concentration ranges.
- Separation in bimodal structure (normal and abnormal), clearest for low idle.
- Low Idle speed is easier to implement in road side control (no driver or RPM electronic control interferences).
- Bimodal structure determines limit of 2.2x10E+5 [#/cm$^3$] as threshold.




| Range | ≥ | < | N | Condition |
|---|---|---|---|---|
| 1 | 1,00E+02 | 2,20E+02 | 12 | Normal |
| 2 | 2,20E+02 | 4,70E+02 | 11 | Normal |
| 3 | 4,70E+02 | 1,00E+03 | 22 | Normal |
| 4 | 1,00E+03 | 2,20E+03 | 30 | Normal |
| 5 | 2,20E+03 | 4,70E+03 | 22 | Normal |
| 6 | 4,70E+03 | 1,00E+04 | 27 | Normal |
| 7 | 1,00E+04 | 2,20E+04 | 33 | Normal |
| 8 | 2,20E+04 | 4,70E+04 | 17 | Normal |
| 9 | 4,70E+04 | 1,00E+05 | 6 | Normal |
| 10 | 1,00E+05 | 2,20E+05 | 4 | Indifferent |
| 11 | 2,20E+05 | 4,70E+05 | 6 | Abnormal |
| 12 | 4,70E+05 | 1,00E+06 | 11 | Abnormal |
| 13 | 1,00E+06 | 2,20E+06 | 15 | Abnormal |
| 14 | 2,20E+06 | 4,70E+06 | 7 | Abnormal |
| 15 | 4,70E+06 | 1,00E+07 | 0 | Abnormal |
| 16 | 1,00E+07 | 2,20E+07 | 0 | Abnormal |
| | | TOTAL | 223 | |

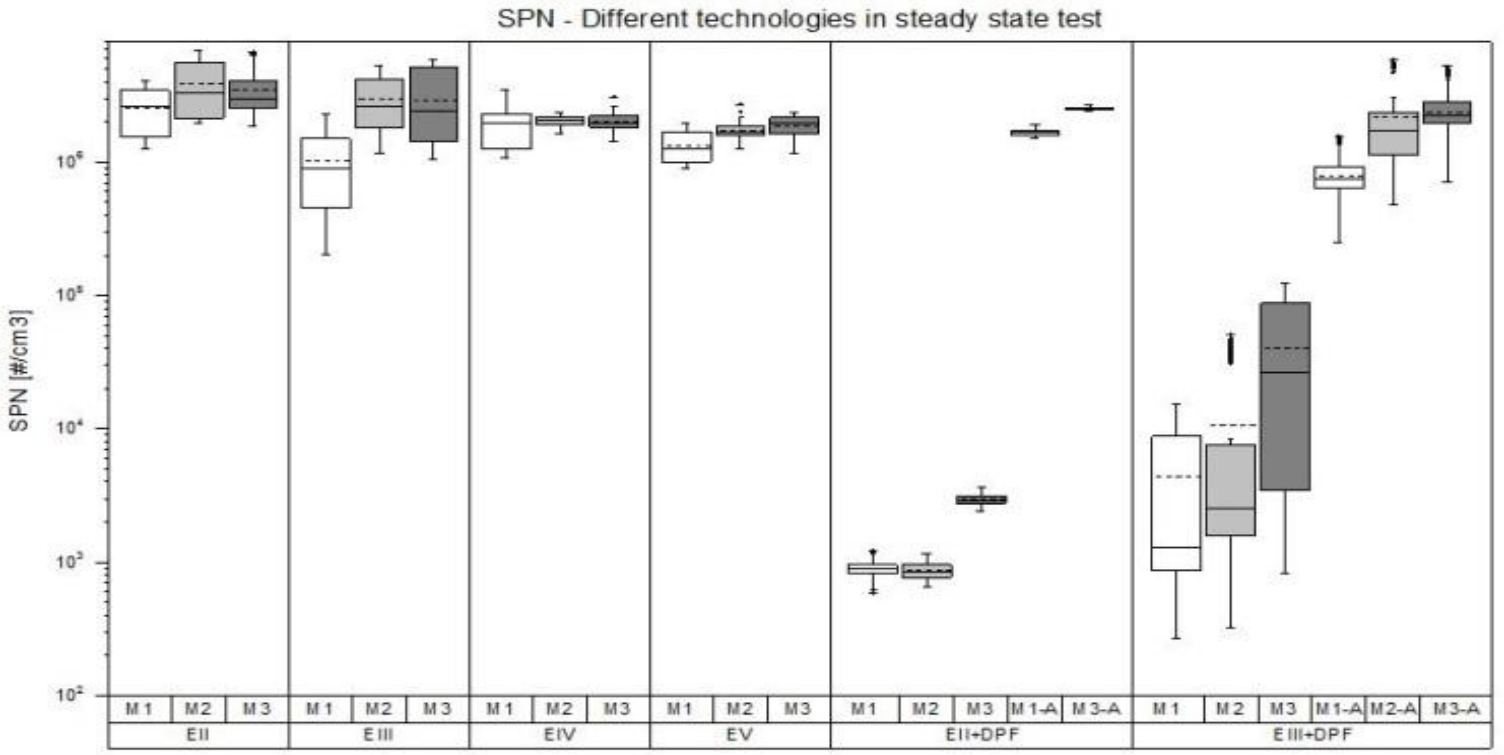
# Bogotá, Colombia

2600 m, S: 30-50 ppm

- Alcalde Mayor changed in 2015 and with him all high and medium level employees of SDA – we lost nearly all contacts
- Legislation to retrofit public transport buses is still in place
- **Financing still not solved** by city / fleet operators contract
- 4 filter systems on the official list of «local approval»
- Policy will probably change: *autorregulacion like Mexico ?*
- Large measurement campaign (SDA) demonstrates the superiority of DPF retrofit – published 21. ETH-NPC
- PN-measurement in streets and buses demonstrate the need
- Principal Problems to introduce Euro VI because of high altitude and sulfur
- *Swiss DEZA intents to continue cooperation but is delayed*

# Three Contributions 21.ETH-NPC from Bogotà

- J.Rueda: Field Evaluations of DPF using solid particle number in Bogotá totally 224 buses measurement with NPET




- L.C.Bonilla: Personal exposure to nanoparticles in 4 roads in Bogotá
- E.Toro: Personal exposure to nano-particles inside Transmilenio Buses

# Nuevos vientos para el ambiente en la ciudad

## Opinión de Néstor Rojas, de la Universidad Nacional

| 22 de octubre de 2016

La contaminación del aire le cuesta a Bogotá más de 2 billones de pesos anuales por cuenta de muertes tempranas y enfermedades que pueden ser atribuidas a los impactos del contaminante más crítico: el material particulado. La mayor parte de esta afectación se presenta en las localidades del suroccidente de la ciudad: Kennedy, Bosa, Ciudad Bolívar, Puente Aranda y Fontibón, sectores con alta densidad de población y en las cuales la norma colombiana de calidad del aire se excede de manera significativa.

A pesar de que se renovó parcialmente la flota de buses, en particular con los buses híbridos que circulan por la avenida El Dorado y la carrera 7.ª, la flota de las primeras dos fases de TransMilenio, ahora vieja y obsoleta, seguirá rodando y contaminando por varios años más, pese a que su reemplazo se debió hacer hace cinco años. Así las cosas, es predecible que la contaminación del aire en Bogotá volverá a aumentar en los próximos años, a menos que el alcalde retome el Plan Decenal y le dé, literalmente, un nuevo aire.

# Mexico Ciudad FD

2600-2800 m; S:10-50 ppm

- March 2016 SEDEMA presented retrofit plans during 7.VERT-Forum 2016 and asked for VERT-support
- May 2016 Mexico introduced accreditation rules for retrofitters of of DPF - meanwhile 4 candidates
- Pilot fleet of 30 buses with filters from 3 VERT members. Discuss installation of GSM/GPS dataloggers
- Retrofit plan for 100 + 400 buses of (city fleets)
- Retrofit plan for > 1000 vehicles via autorregulación to overcome «hoy no circula»
- January 2017 interamerican policy conference, patronat CAF *the development bank of latin america: NanoMet 3*
- Planning cooperation and planning chassis dyno installation

CDMX
CIUDAD DE MÉXICO

SEDEMA

SECRETARÍA
DEL MEDIO AMBIENTE

# RETROFIT VEHICLES IN MEXICO CITY


## MINISTRY OF ENVIRONMENT AND PASSENGER TRANSPORT RED

# MEXICO CITY METROPOLITAN AREA


**Mexico City Metropolitan Area:**

16 boroughs of Mexico City

59 municipalities of the state of Mexico

1 municipality of the state of Hidalgo.

**Mexico City Metropolitan Area population:**

Just over 20 million, making it the largest metropolitan area in North America followed by the New York metropolitan area.

**Mexico City Metropolitan Area geography and environment:**

Spreads over the valley of Mexico, at an average of 2,240 m (7,349 ft) above sea level.

The valley of Mexico is surrounded by mountains creating a basin with only one small opening at the north, trapping all exhaust emissions of the city.

# RTP's vehicle categories foreseen for DPF retrofit

| Type | & N° of this type | Kind of Service (Scholar bus, Trunk, Zonal) | Chassis | | Engine | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Brand & model | Ø age | Brand & model | Ø age | Ø km per year | Power (kW) | Emission class |
| A | 239 | Ordinary | Mercedes/Benz/Torino | 2006 | OM906LA | 2006 | 85,000 | 230 | EURO III |
| B | 145 | Expreso | Mercedes/Benz/Torino | 2009 | OM906LA | 2009 | 86,000 | 230 | EPA04 |
| C | 105* | Scholar bus | International /Reco | 2009 | DT466 | 2009 | 15,000 | 175 | EPA04 |

*first stage

- **Retrofit (with DPF) of ≈ 105 scholar buses in two steps**
  - Step 1: retrofit N* buses and run a 3-month demonstration test in real operation. *N necessary to demonstrate compatibly (minimum 3)
  - Step 2: if all retrofits successfully pass the test, implement the remaining 147 buses
- **Establishment of a local DPF service organization in cooperation with a competent local firm / representative**
  - providing support to DPF provider for the installation of the DPFs
  - performing aftersales DPF service / maintenance of all installed DPFs (in accordance with aftersales service contract)
- **Certified DPF system according FOEN and CARB list**

# Accreditation
## for DPF
## Retrofit Companies

CDMX
CIUDAD DE MÉXICO

**GACETA OFICIAL DE LA CIUDAD DE MÉXICO**

Órgano de Difusión del Gobierno de la Ciudad de México

| DÉCIMA NOVENA ÉPOCA | 17 DE MAYO DE 2016 | No. 73 |
|---|---|---|

**Í N D I C E**

**ADMINISTRACIÓN PÚBLICA DE LA CIUDAD DE MÉXICO**



**Continúa en la Pág. 2**

# Conference Jan.2017

and implementation of PN-measurement with NanoMet 3



**Draft Program**

**STRATEGIES FOR MITIGATING AIR POLLUTION**
**18 &19 January 2017, Mexico City**

**Place: NH Centro Histórico,**
**Palma, 42 Centro 06000 Ciudad de México - México**
**Historic Centre**

**Wednesday, 18 January 2017**

| | |
|---|---|
| **08:30** | **Registration of the participants** |
| **09:00** | **Opening Remarks** |
| **09:20** | **Working session 1: Air pollution in Mexico City, standards and real world emissions.** Both peak (daily photochemical smog episodes as high annual pollution averages in Mexico City are driven primarily by NOx emissions from road transport. Emissions of particulate matter are also of increasing concern. Understanding the difference between the quantity of NOx and PM emitted in lab tests and on-road conditions is fundamental to designing effective pollution counter measures. The session will describe measures that have been effective to ensure that standards are being achieved, in particular strategies that monitor vehicles on the road.<br><br>**Moderator:** Stephen Perkins, Head of Research and Policy Analysis, International Transport Forum.<br><br>• **International Transport Forum** – General overview on automotive air pollutant emissions in Mexico City (20 min).<br>• **Norbert Ligterink, TNO (background paper)** – Euro standards and real world emissions.<br>• **Andreas C.R. Mayer -** Policy priorities to eliminate toxic emissions from urban traffic-(20 mins)<br>• **Kate Blumberg, ICCT** – NOx, tailpipe and evaporative VOCs and particulate emissions in real world driving conditions (20 mins)<br>• **Gianni López, Centro Mario Molina, Chile (by video conference)** – Emerging issues with particulates from gasoline direct injection car engines: evidence from Santiago de Chile (20 min). |

# Cooperation

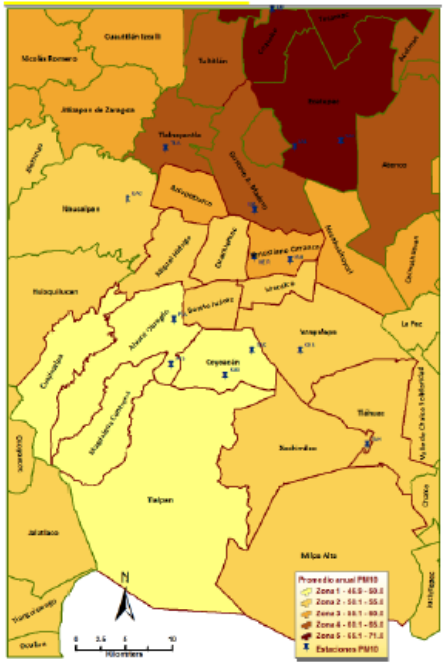
## Programa de asesoría CAF al

## Proyecto de Filtros de Partículas en Ciudad de México

**Preparado para el Banco de Desarrollo de América Latina (CAF)**

### 1 Introducción

Ciudad de México, a una altura de 2600 m sobre el mar, **encerrado por un** corona de sierras, es una de las ciudades más grandes de América Latina, sufre graves problemas de contaminación. La Zona Metropolitana del Valle de México (ZMVM) excede el límite mexicano para el promedio anual del MP10 de [µg/m$^3$], como se muestra en la siguiente figura:




Distribución de MP10 (concentración promedio anual), para 5 zonas de ZMVM, valores 2005.
Fuente: PROAIRE 2011-2020

# Conclusions

- The retrofit Success of Santiago is guiding other Latin American Megacities
- High altitude of many LA megacities is a common and serious problem for retrofit as well as for **Euro VI-introduction** → working group with JRC, TÜV, JICA et al.
- Introduction of modern inspection and maintenance is a common requirement: **NPTI is a must**
- Emission reduction measures for NRMM and for petrol engines are required as well
- **Use of the Mexican model to exempt from "hoy no circula" by DPF retrofit might become a strong incentive and a good financing model**