



GHG/Air Quality Measurements in Brazil

Surface measurements

Maria de Fatima Andrade

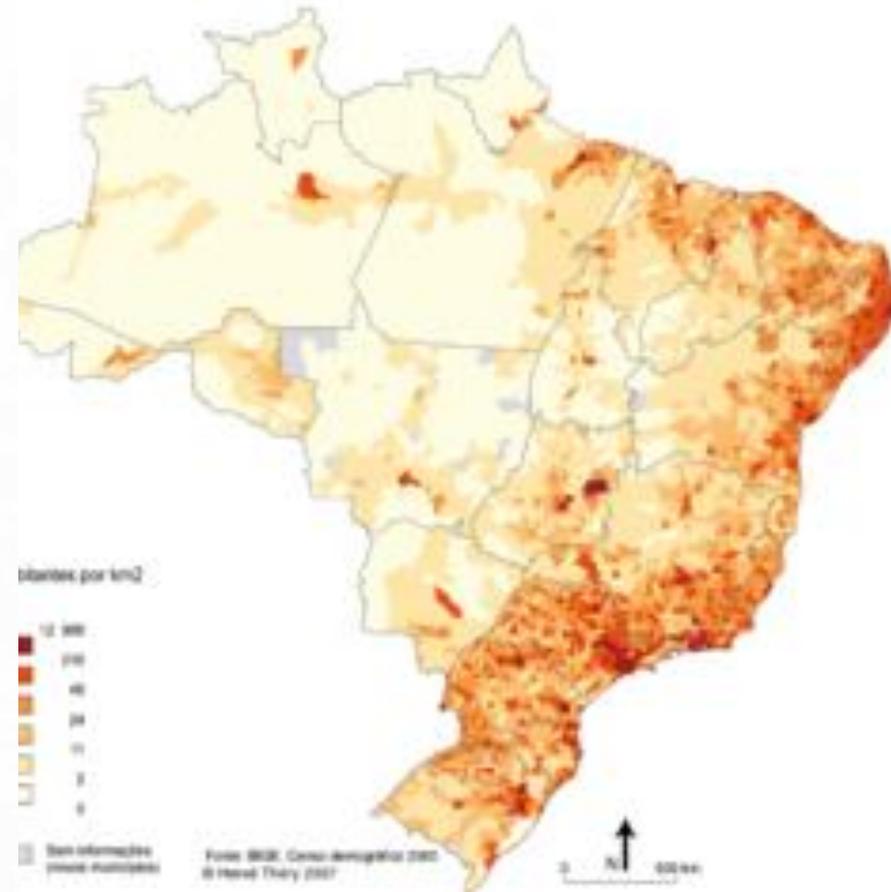
Departamento de Ciências Atmosféricas

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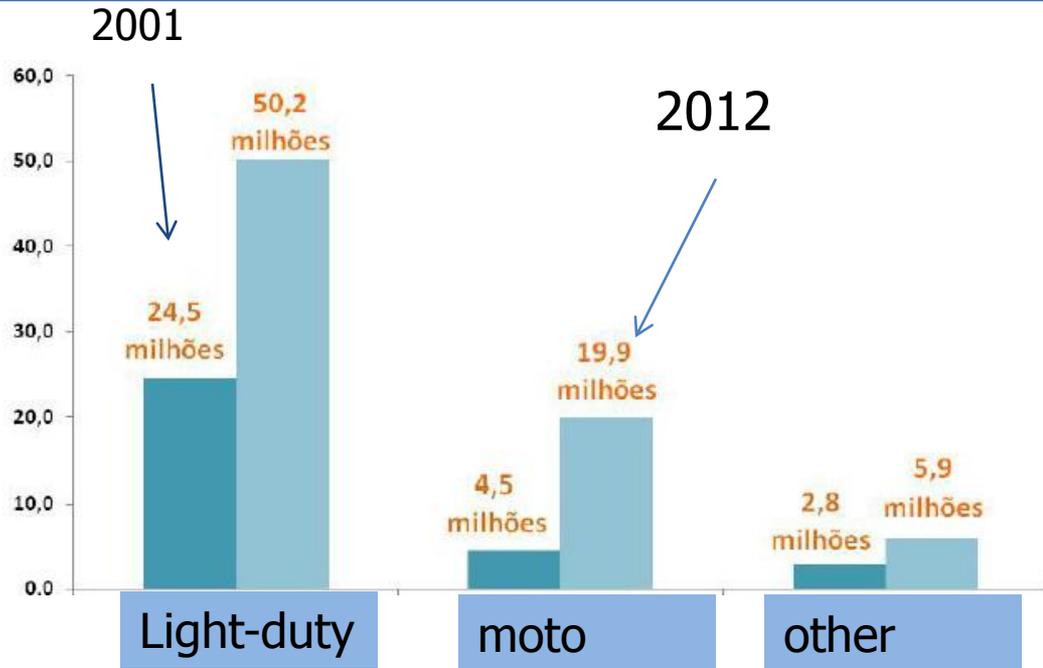
University of São Paulo



Population density



Population of Brazil 202.768.562



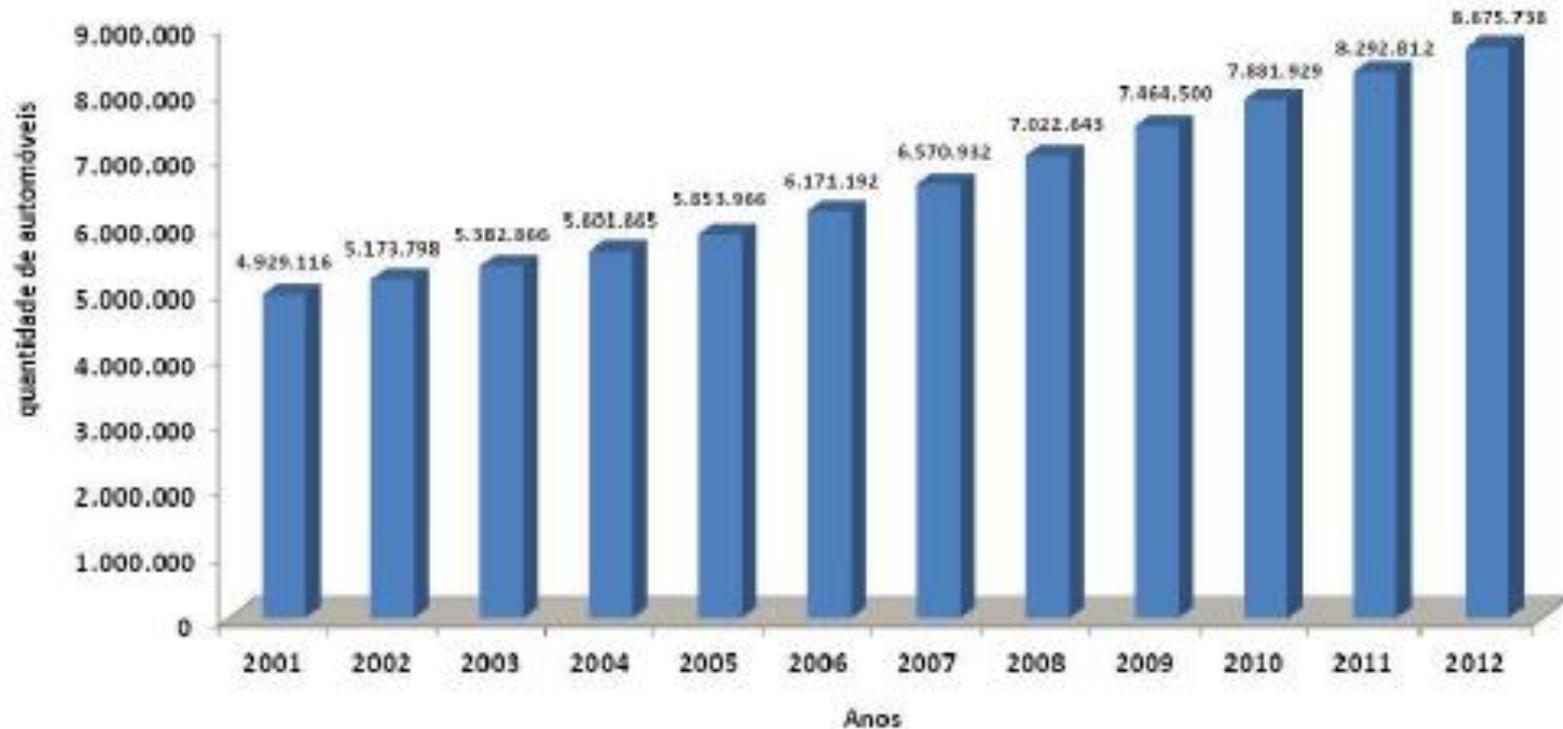
Number of vehicles in 2001 and 2012

Brasil

Fleet composition

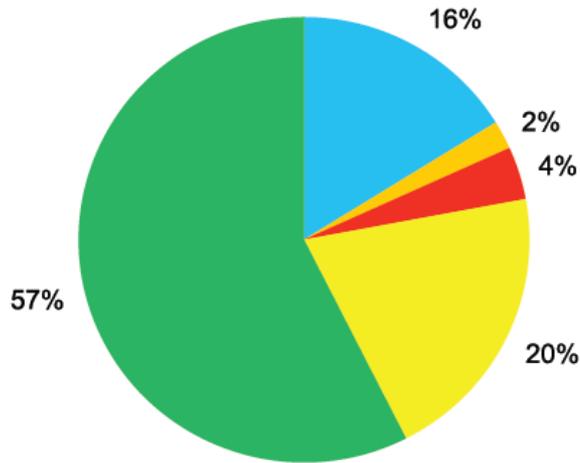


Growth of Fleet in the Metropolitan Area of São Paulo from 2001 to 2012



Fonte: Elaborado pelo Observatório das Metrôpoles com dados do DENATRAN.

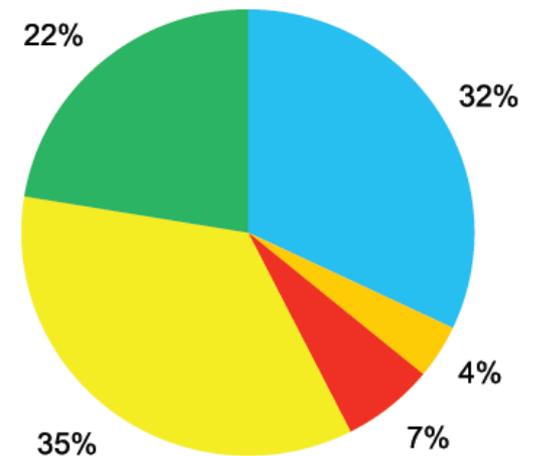
Emission sources of CO₂eq in São Paulo



2005

- **Energy**
- **Solid Waste Disposal**
- **Industry**
- **Agriculture and pecuaries**
- **Land use and Forest**

2010



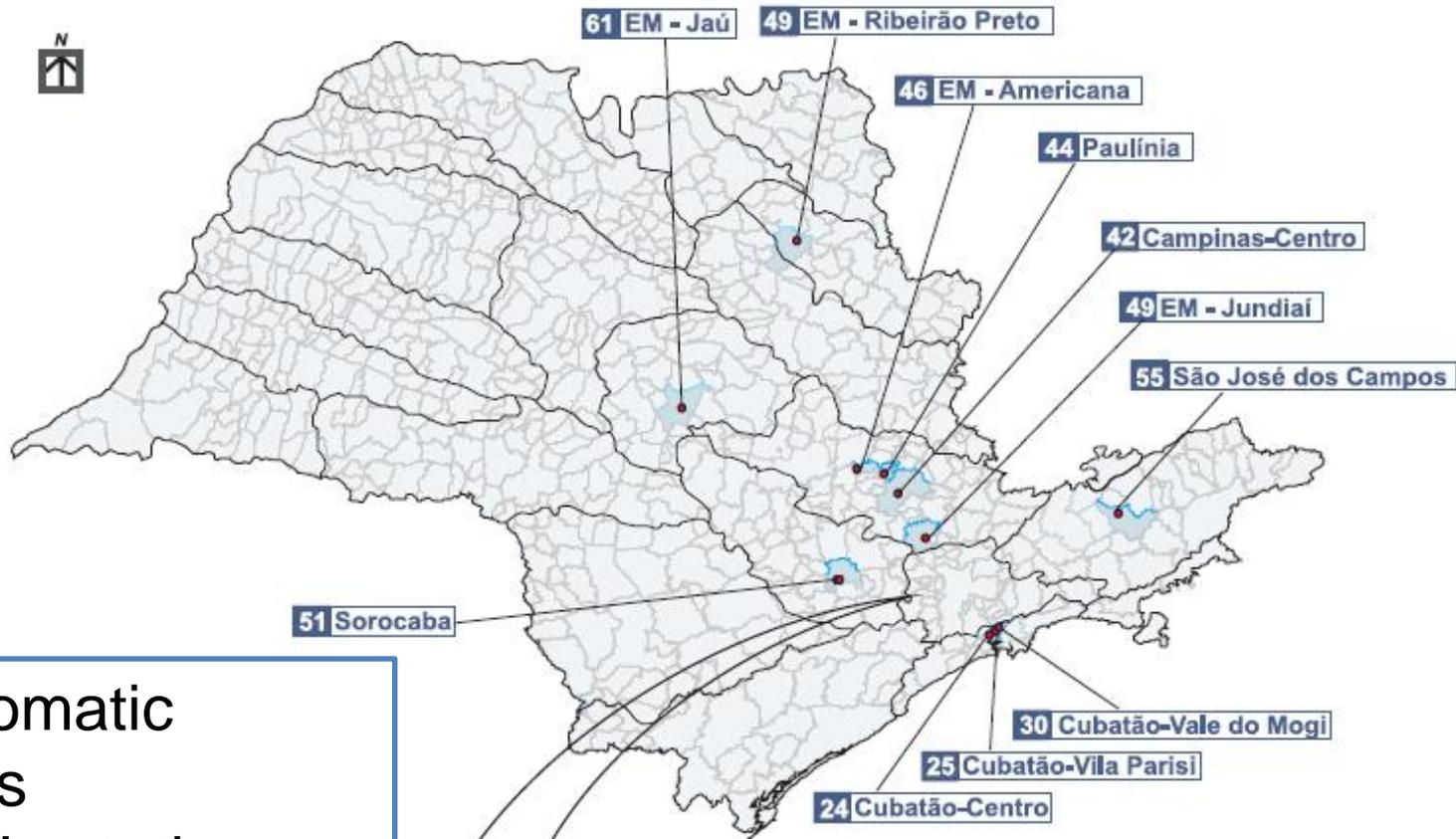
Importance of measuring GHG and Co-Pollutants

- Not only to analyze the air quality
- Evaluation of emission inventories
- Evaluation of effectivity of the implementation of public policies

- Air quality stations are presented in most capital cities in Brazil

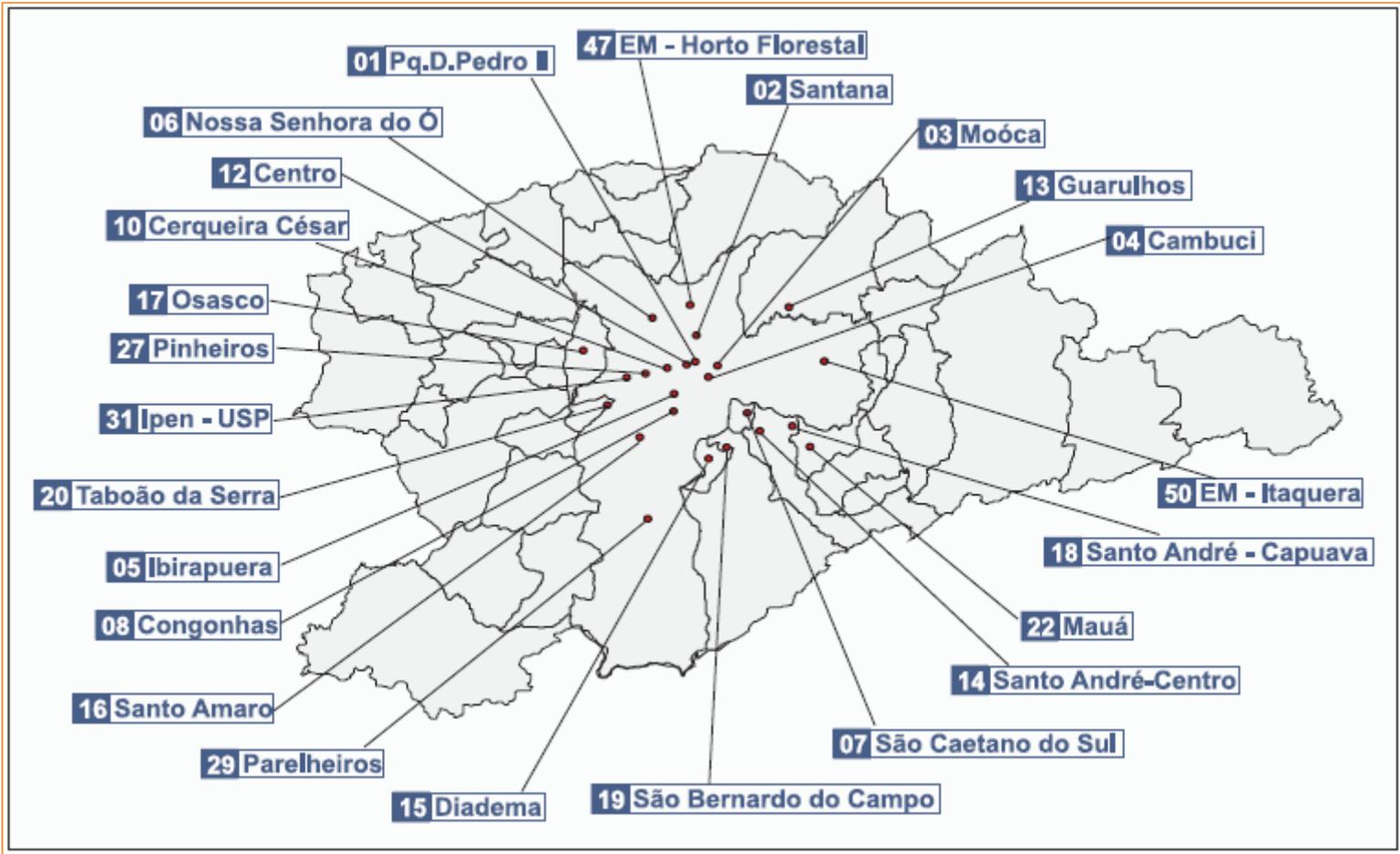
- GHG are measured by research groups (mainly fluxes in forest, sugar cane plantations, cerrado, etc)
- In São Paulo we started two ground stations to measure CO₂ and CH₄ continuously with a Picarro Monitor.

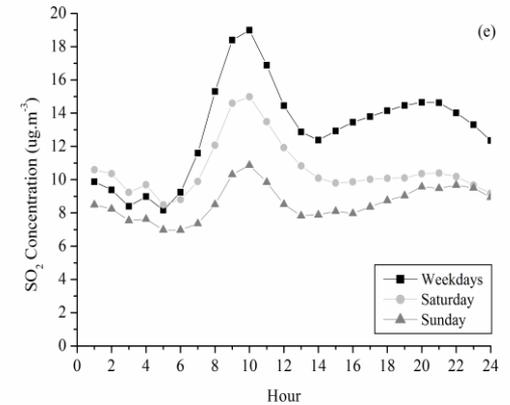
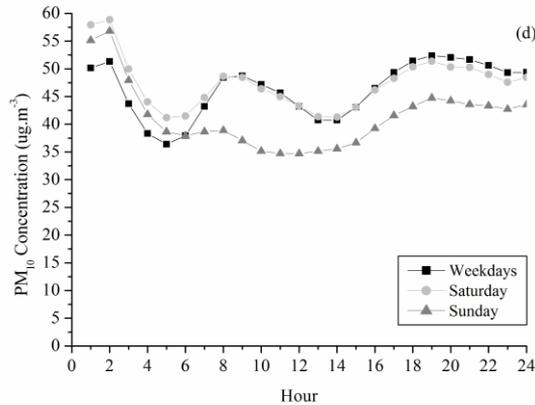
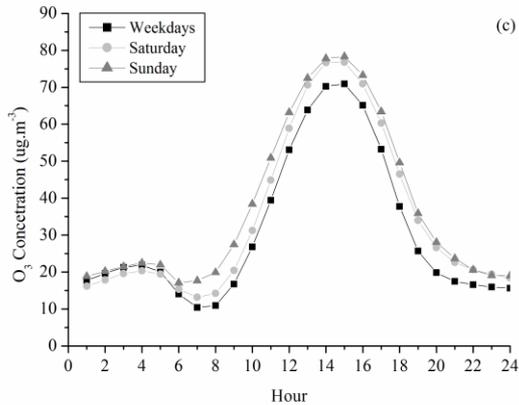
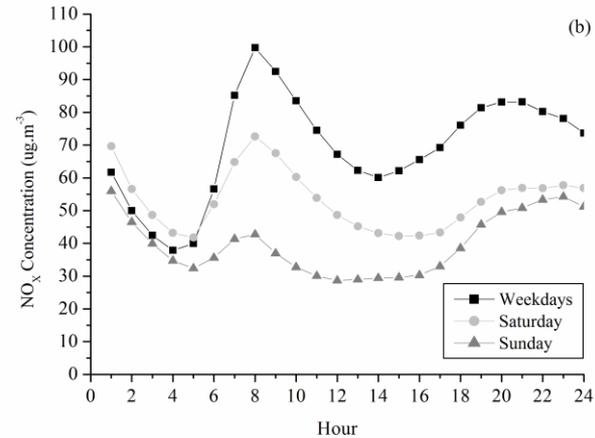
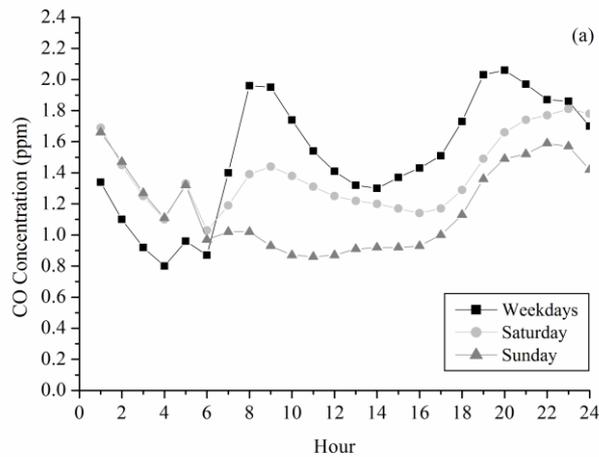
Air quality Monitoring Stations from CETESB Environmental Agency from São Paulo State



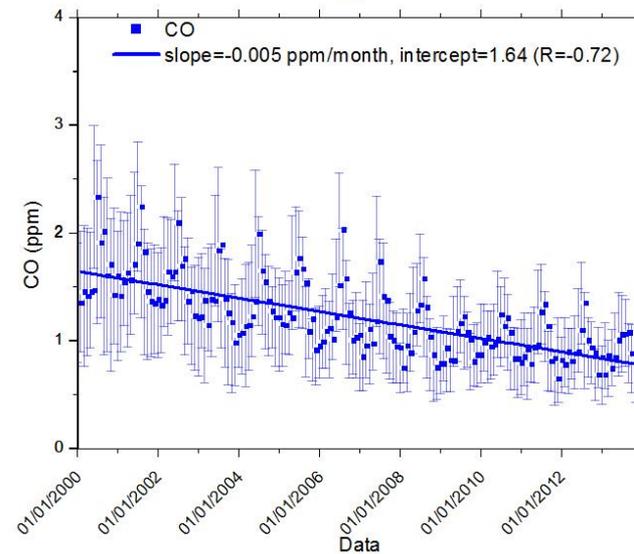
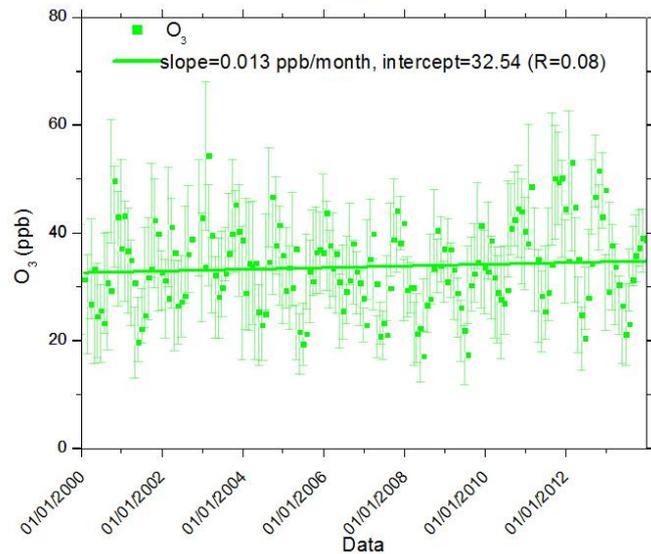
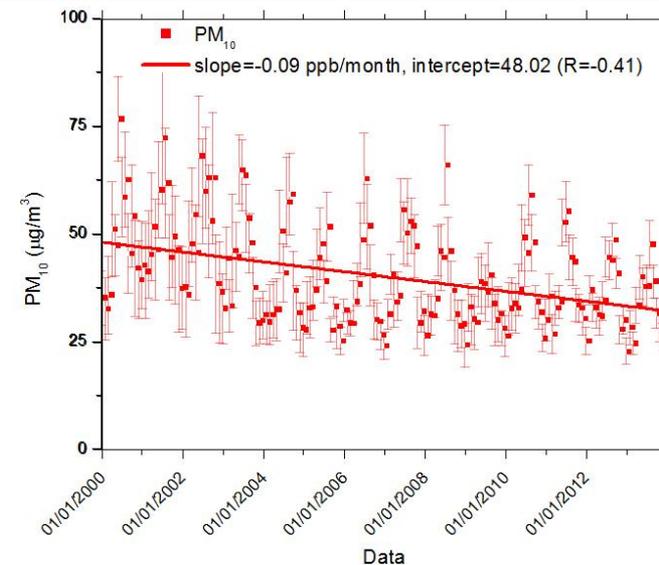
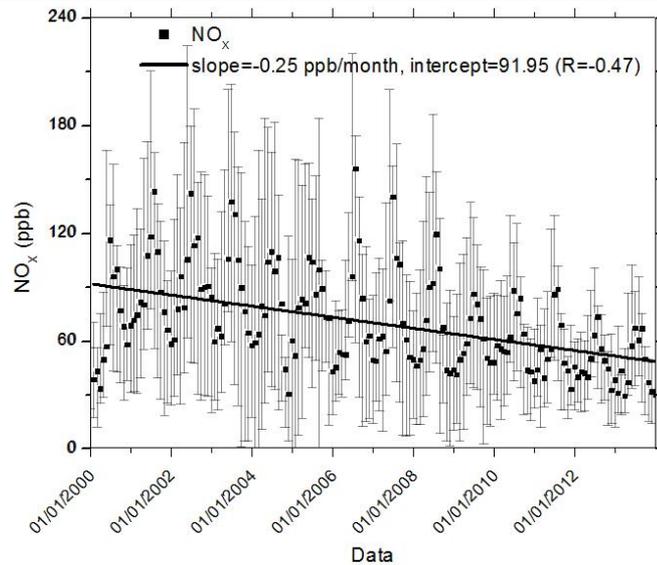
49 automatic
stations
2 mobile stations
39 manual
sampling site

Air quality Monitoring Stations from CETESB – Metropolitan Area of Sao Paulo

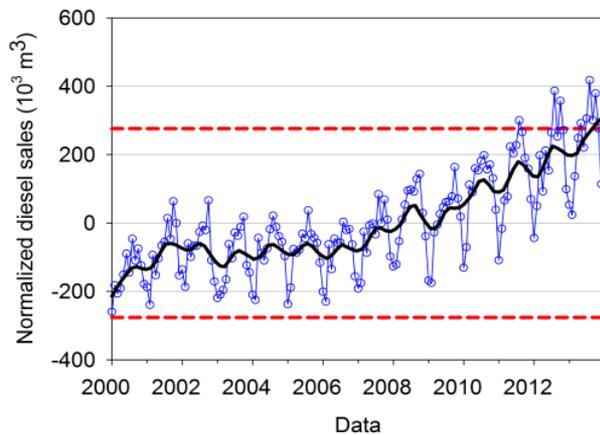
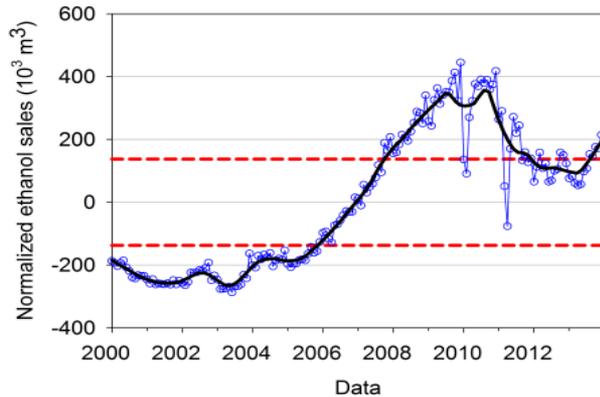
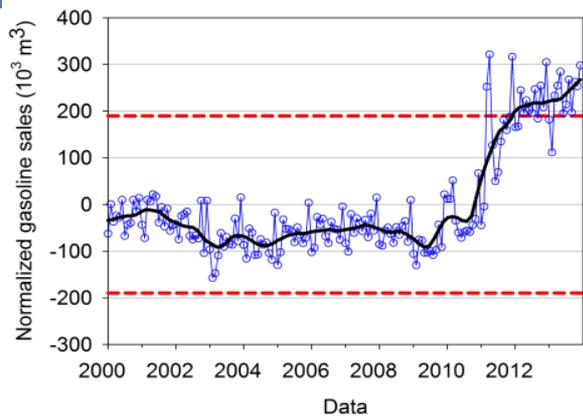




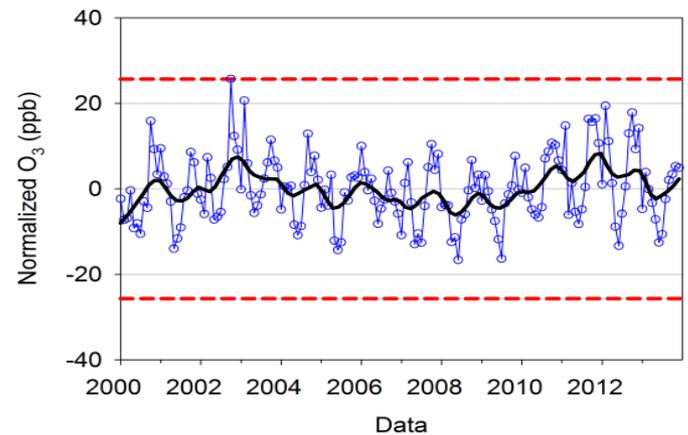
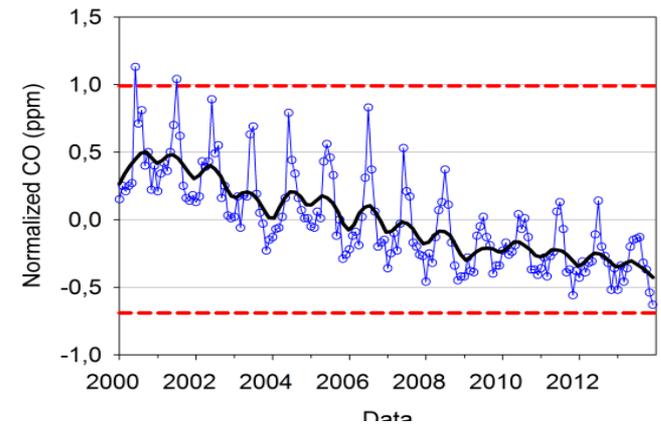
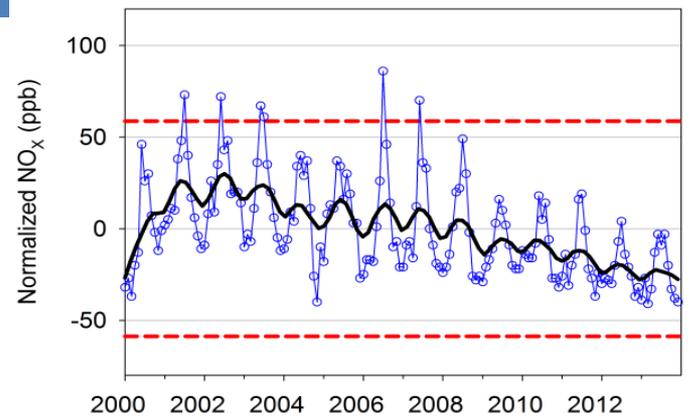
Mean concentrations of (a) CO (ppm), (b) NO_x (ug m⁻³), (c) O₃ (ug m⁻³), (d) PM₁₀ (ug m⁻³) and (e) SO₂ (ug m⁻³) measured in the monitoring stations in the MASP according to the hour of the day and the day of the week, calculated during the period from 1996 to 2009.



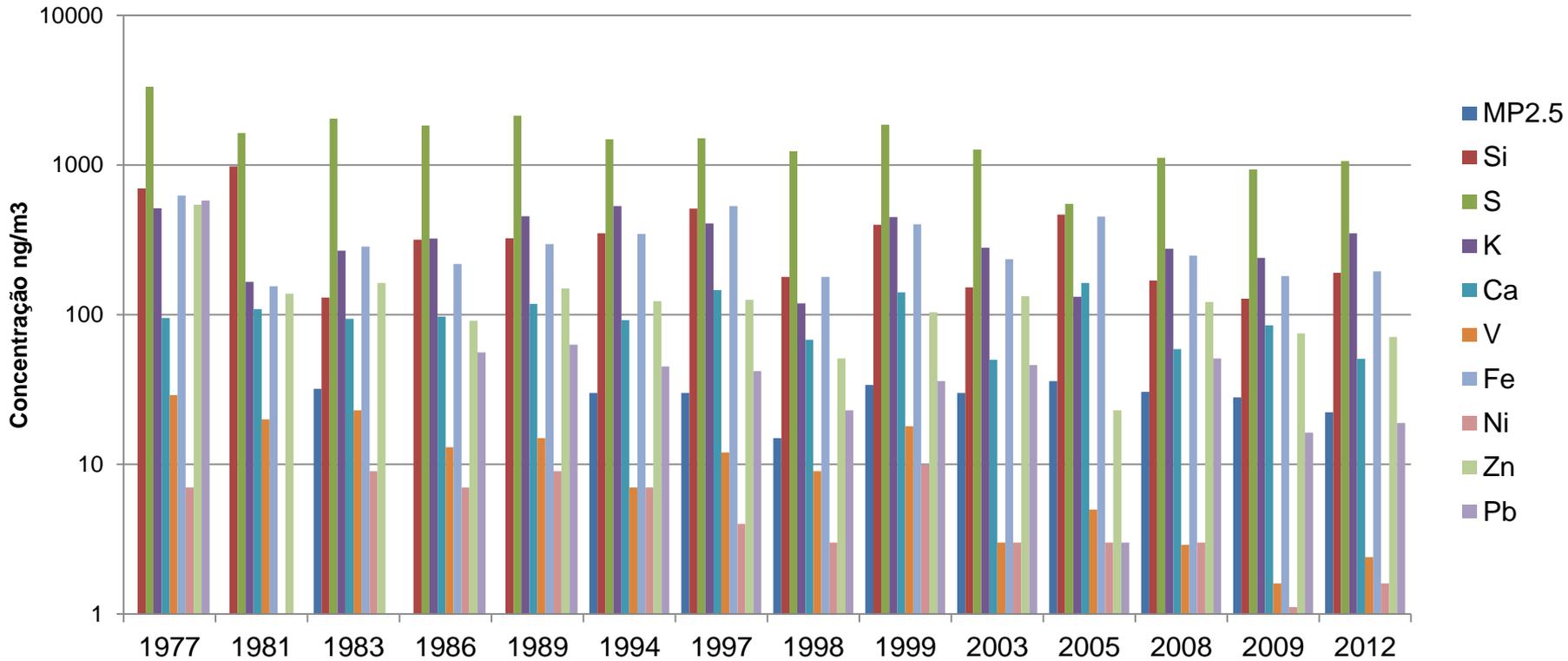
Monthly variations in selected air pollutants in São Paulo. Solid regression lines show monthly mean concentrations used in this paper. Error bars summarize the relative uncertainties in pollutant concentration measurements. Data are from the São Paulo Environmental Company CETESB, 2000–2013 (<http://www.cetesb.sp.gov.br/ar/qualidade-do-ar/32-qualar>)



Plots in the left panels show the monthly mean fuel sales for gasoline (mean of $642.7 \cdot 10^3$ and standard deviation of $\pm 37.9 \text{ m}^3 \text{ month}^{-1}$), ethanol ($374.8 \cdot 10^3 \pm 27.5 \text{ m}^3 \text{ month}^{-1}$) and diesel ($854.1 \cdot 10^3 \pm 55.2 \text{ m}^3 \text{ month}^{-1}$), and the concentration for NO_x ($70.2 \pm 11.7 \text{ ppb}$), CO ($1.20 \pm 0.14 \text{ ppm}$) and O_3 ($70.2 \pm 11.7 \text{ ppm}$). The values are normalized to the long-term means. The black curves are monthly weighted regression smoothing fits.



Elementar composition in PM2.5 – São Paulo

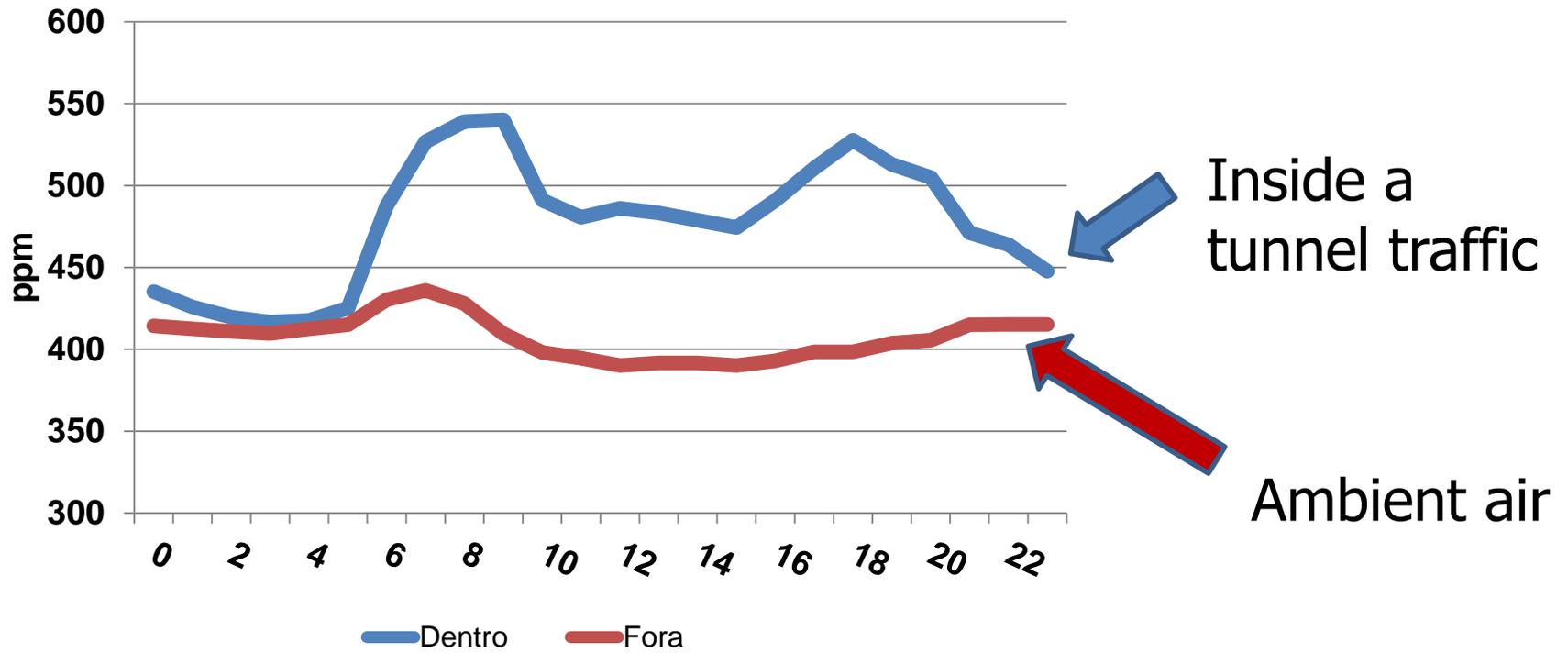


Historical Data

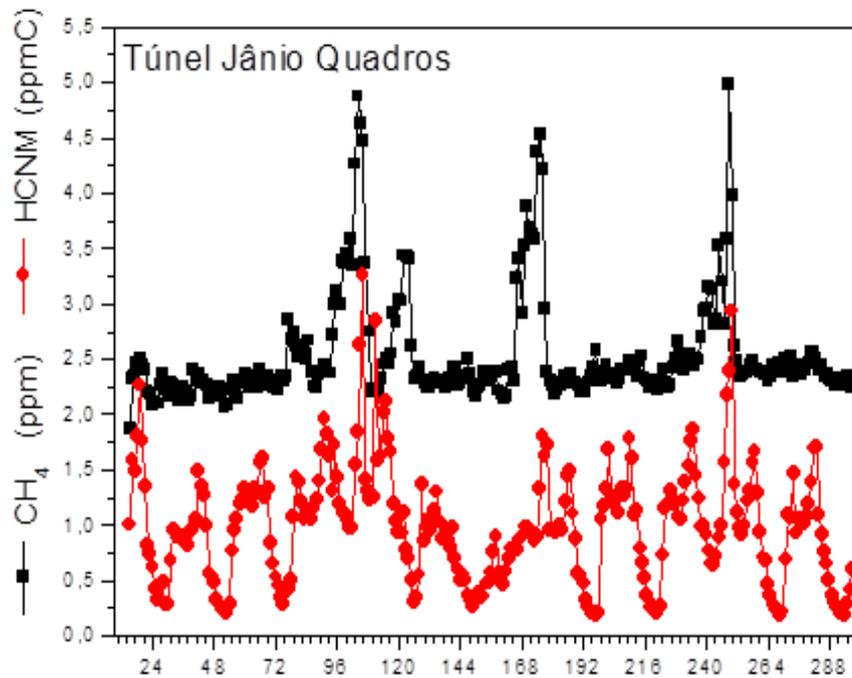
S and Pb decrease







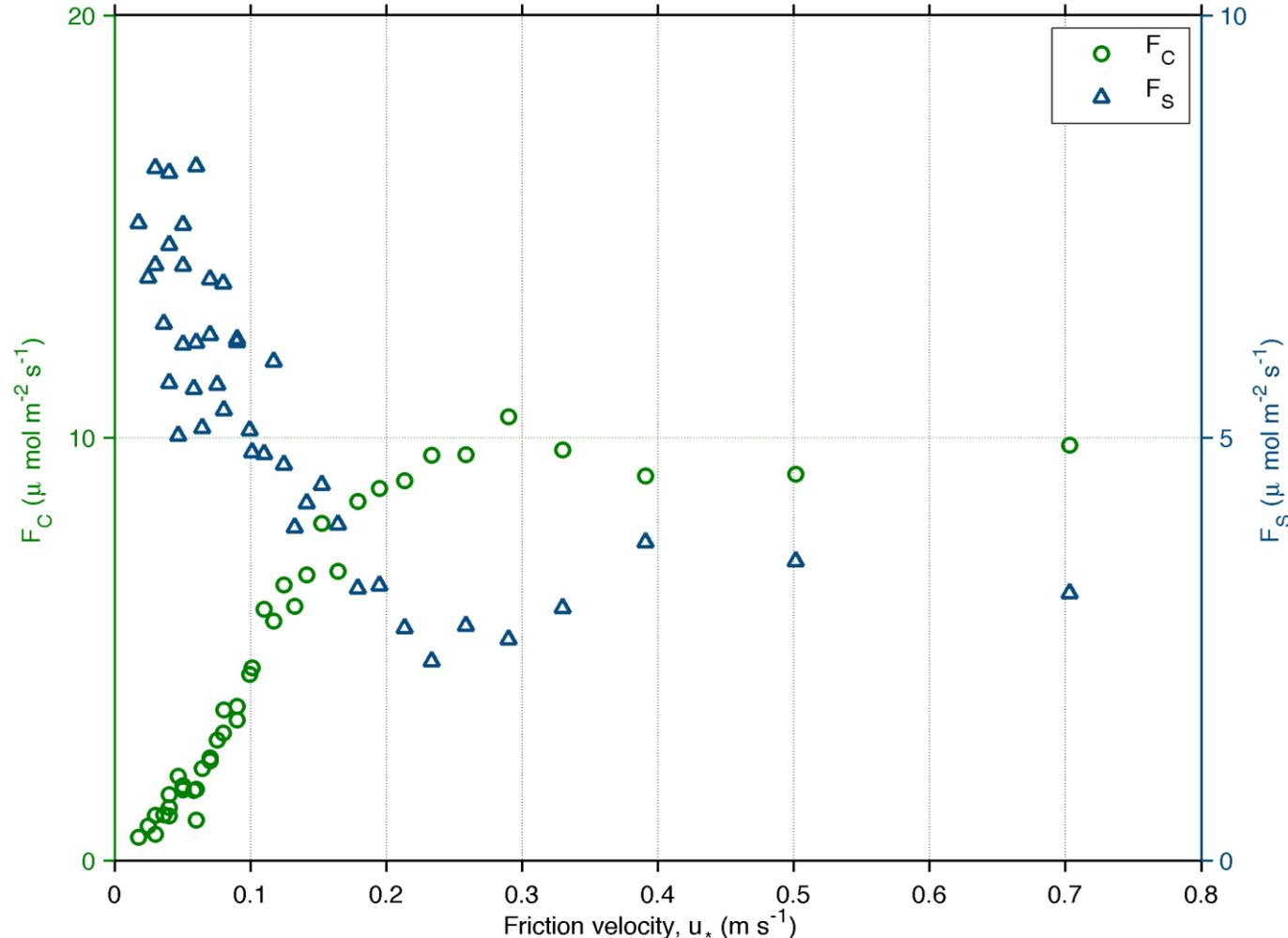
Measurements of CO2



Inside a tunnel
traffic

CH₄ and HCNM

CO₂-flux (F_C) and storage (F_S) plotted versus classes of friction velocity – Rondonia site



Variability of Carbon and Water Fluxes Following Climate Extremes over a Tropical Forest in Southwestern Amazonia

Marcelo Zeri

Leonardo D. A. Sá

Antônio O. Manzi

Alessandro C. Araújo

Renata G. Aguiar

Celso von Randow

Gilvan Sampaio

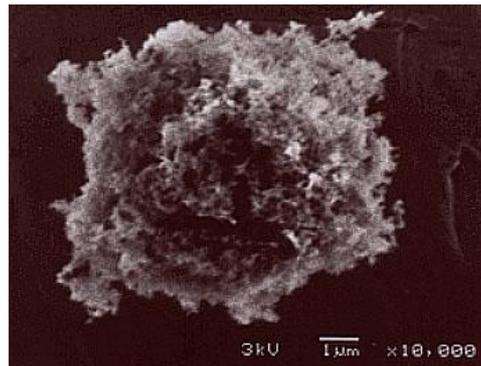
Fernando L. Cardoso

Carlos A. Nobre

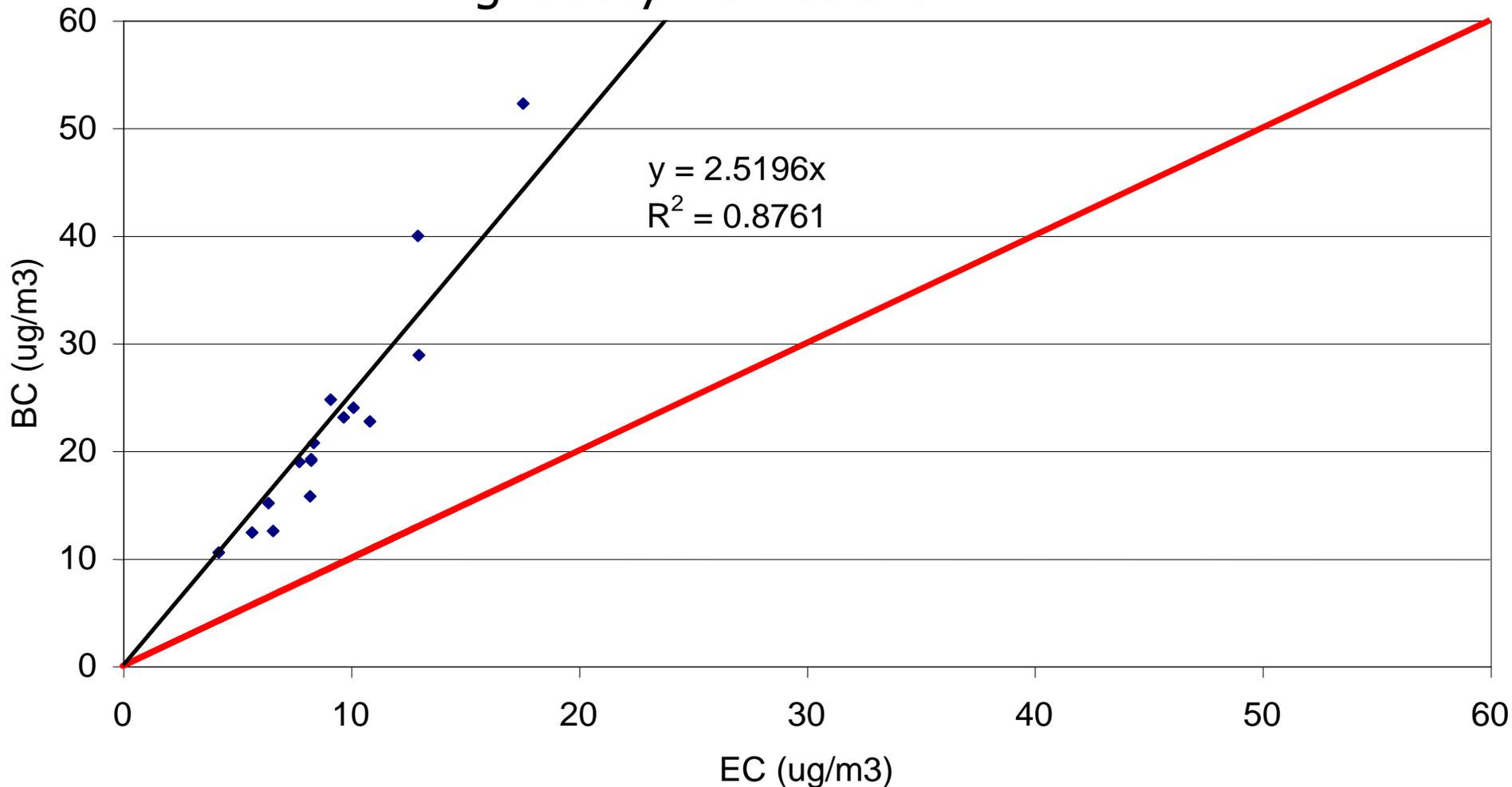
2014

Measurements of Black Carbon

- Important because of warming effect
- What is being measured?
 - Black Carbon Equivalent?

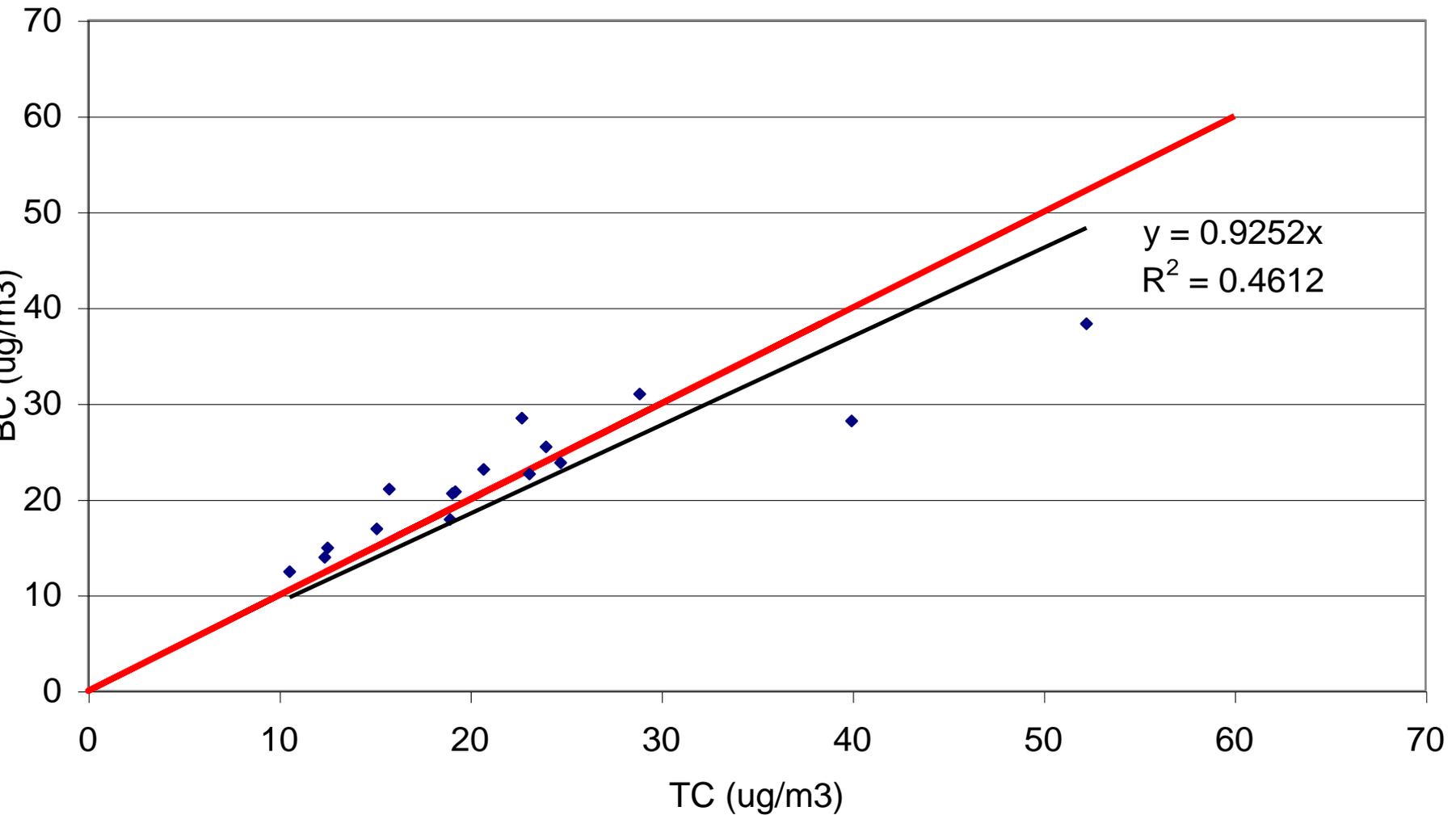


Light duty - emissions



Points very well aligned but much more BC (2.5X) than EC (some of the OC is refractive and while Sunset calls it OC, other technique measures as BC)

Light duty - emissions



BC aligns very well with total carbon (TC)

**METHODOLOGY FOR ESTIMATION OF
VEHICULAR SOURCES CONTRIBUTION TO
AMBIENTAL PM_{2.5} CONCENTRATIONS IN THE
SIX METROPOLITAN AREAS**

| Metropolitan Area | Population (million) | Area (thousand km ²) |
|-------------------|----------------------|----------------------------------|
| São Paulo | 19.9 | 7.9 |
| Rio de Janeiro | 11.8 | 5.6 |
| Belo Horizonte | 5.0 | 0.9 |
| Porto Alegre | 9.8 | 4.1 |
| Curitiba | 3.2 | 15.4 |
| Recife | 3.8 | 2.8 |



Recife

Belo Horizonte

Rio de Janeiro

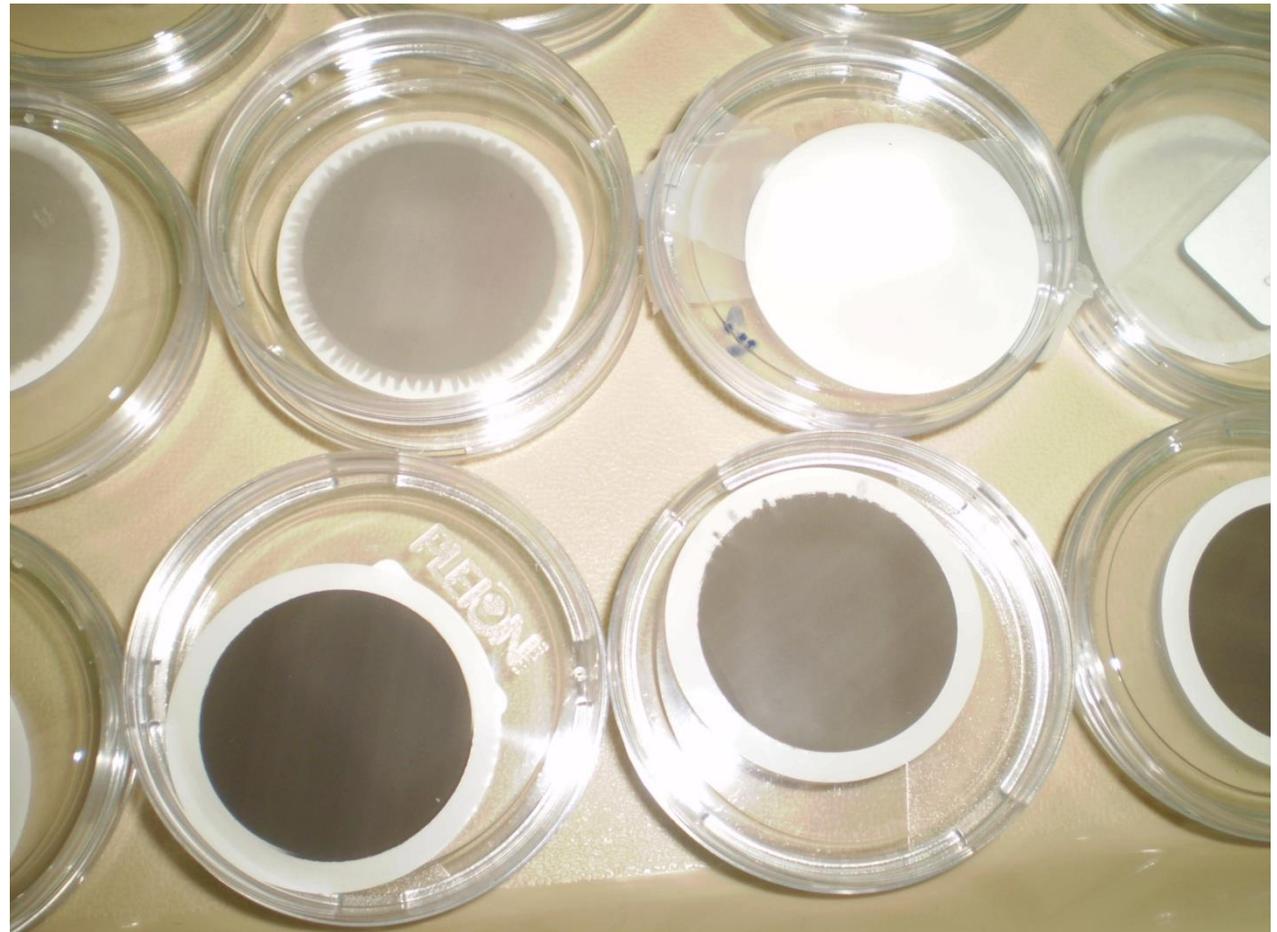
São Paulo

Curitiba

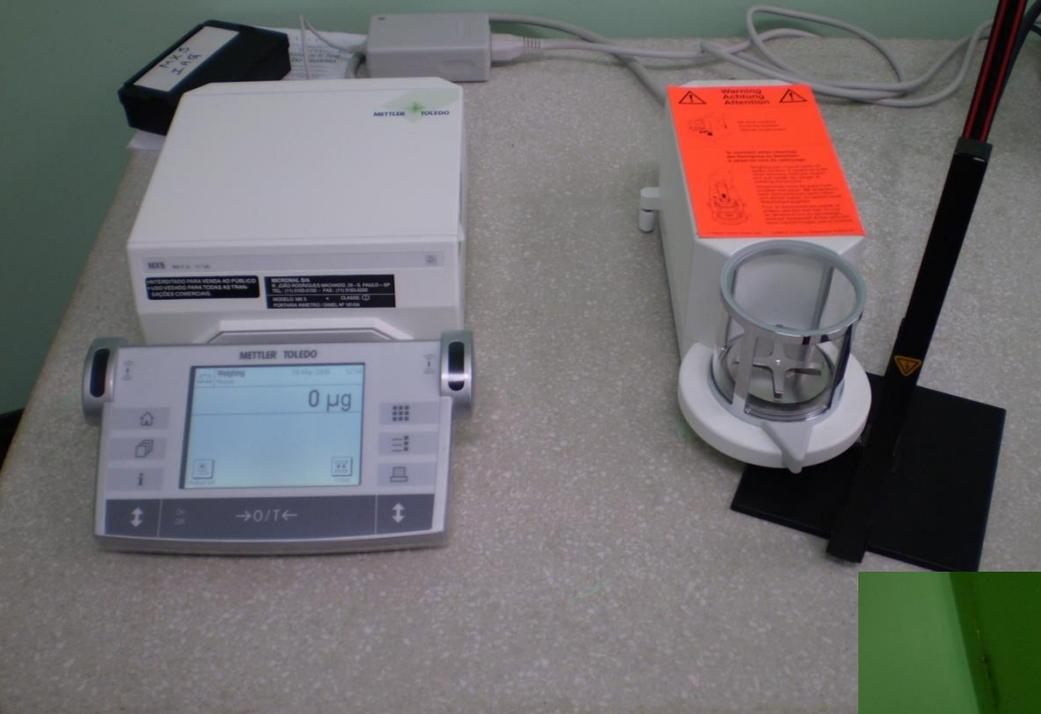
Porto Alegre

Examples of sampled filter, which are weight before and after sampling

- 24 hours sampling
- Simultaneously in the six cities
- 2 years of daily sampling



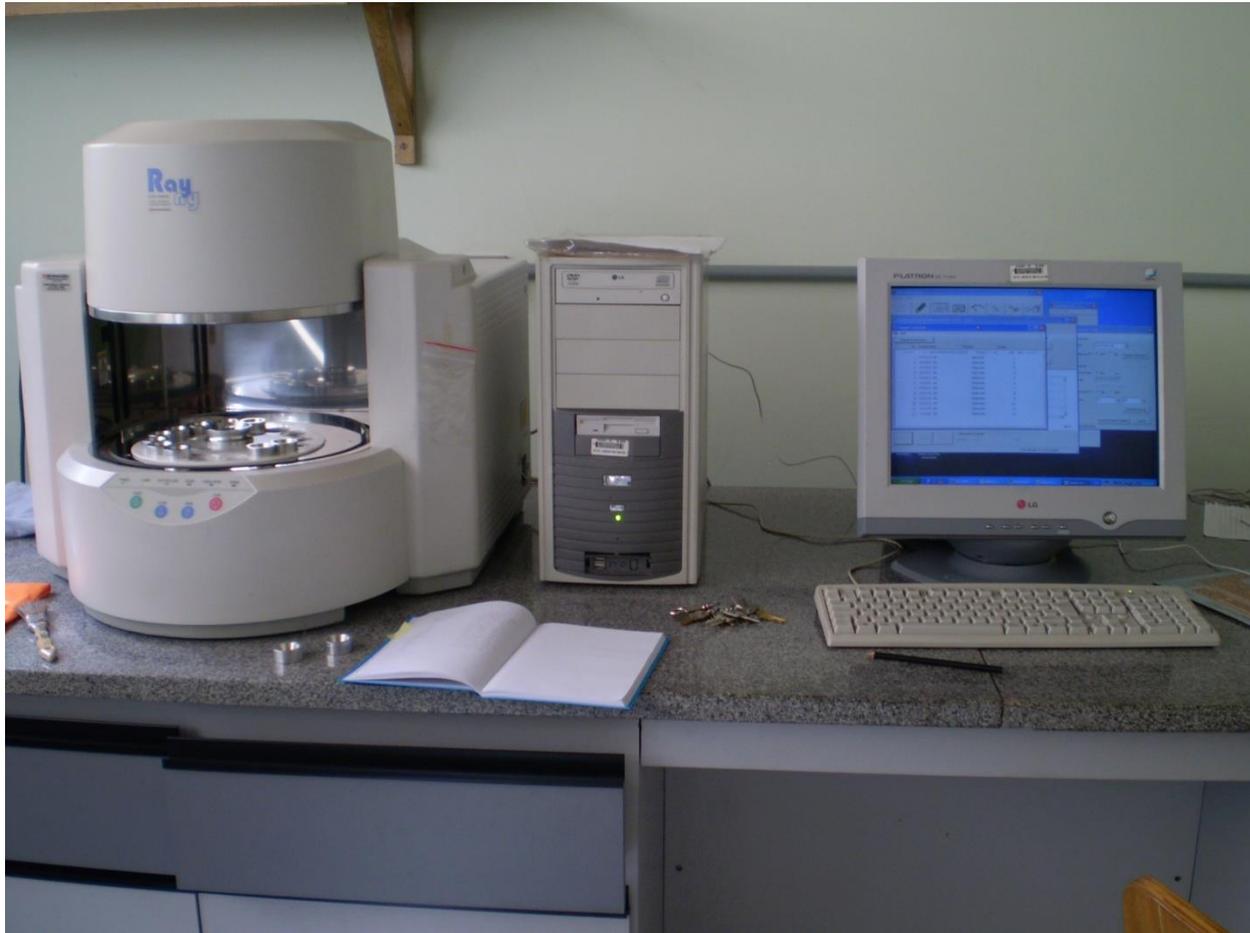
Instrument to take out static
Electricity from filters



**Analytical Microbalance
with sensitivity of μg**

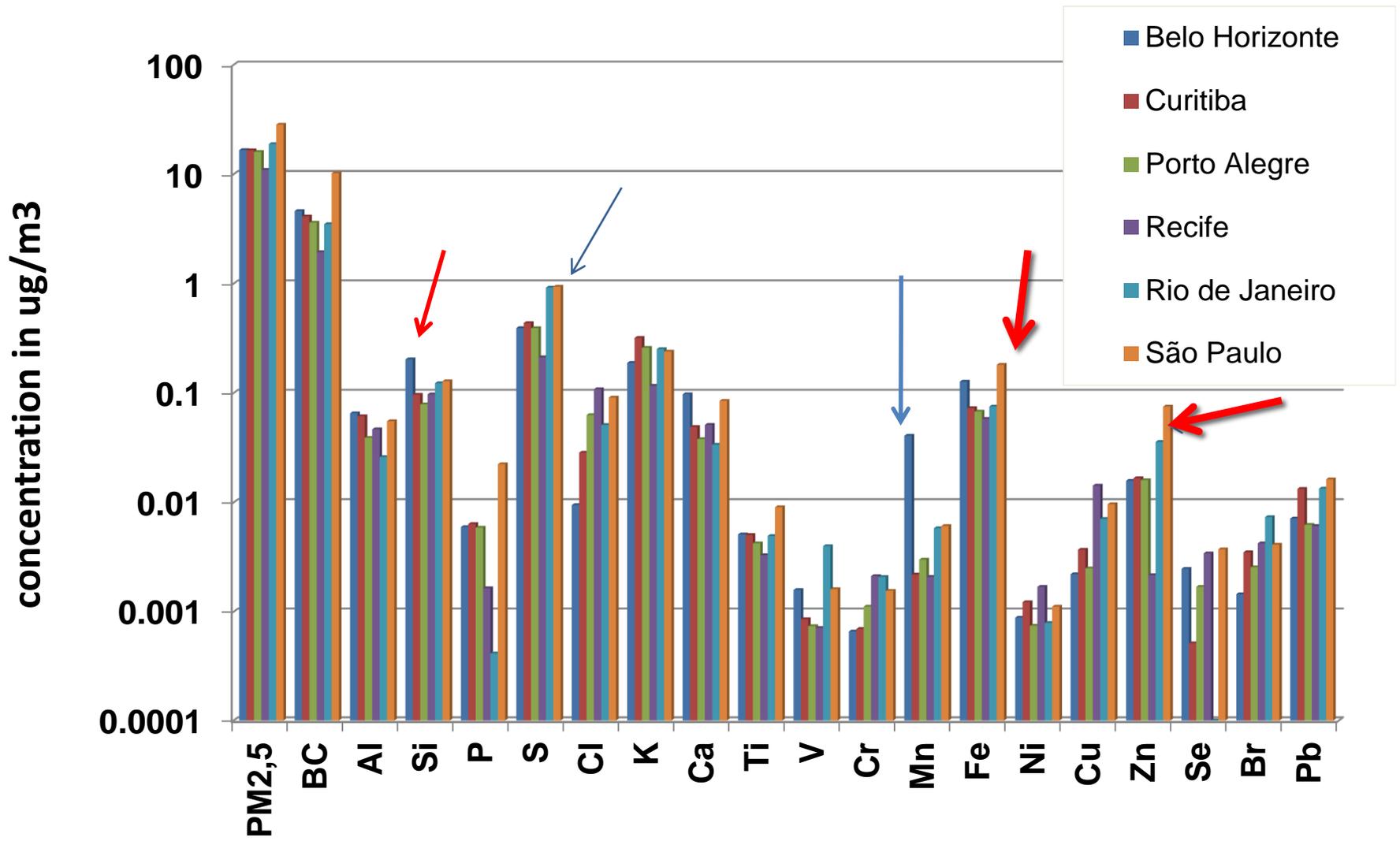


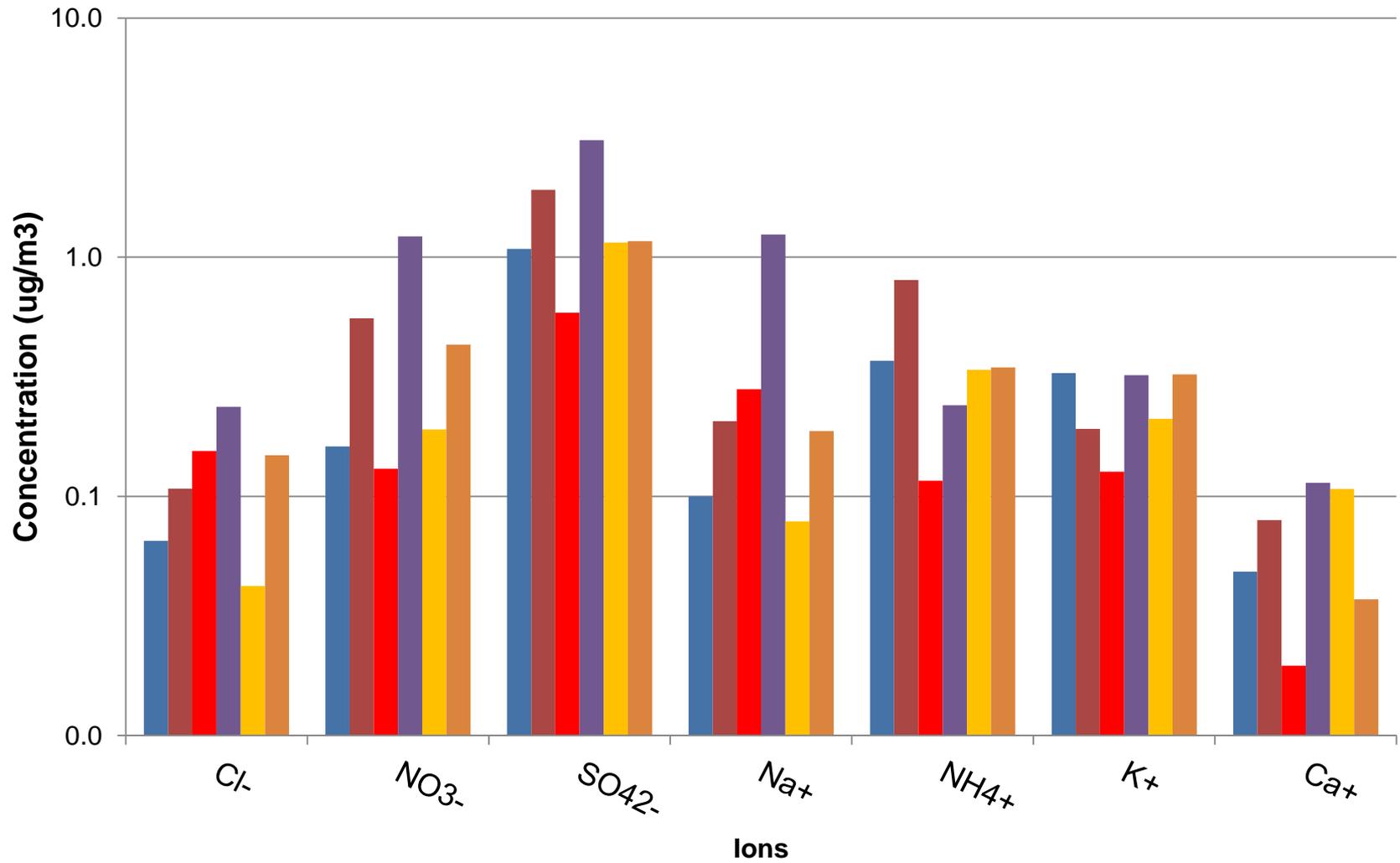
EDX (*Energy Dispersive X-ray Fluorescence*)



PM_{2.5} Average mass concentration
July 2007 – October 2009
Concentrations in $\mu\text{g}/\text{m}^3$

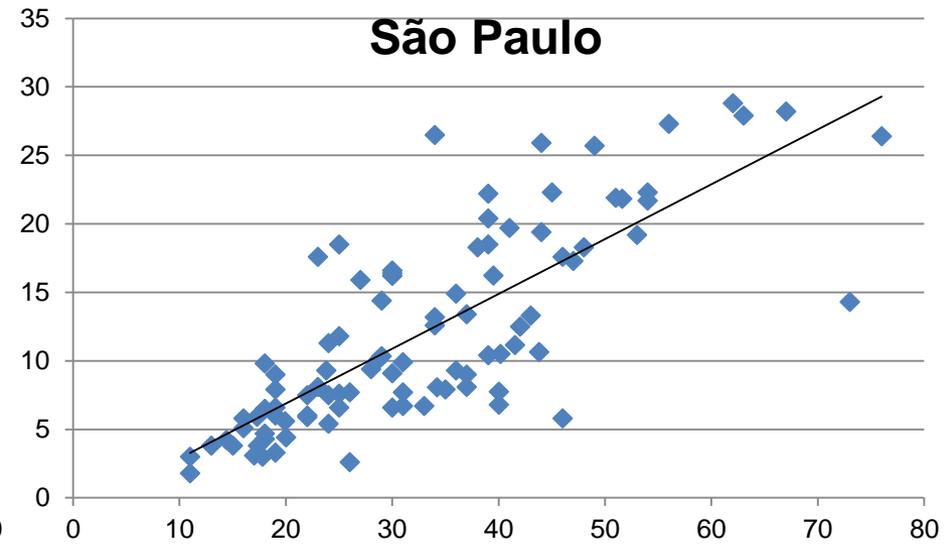
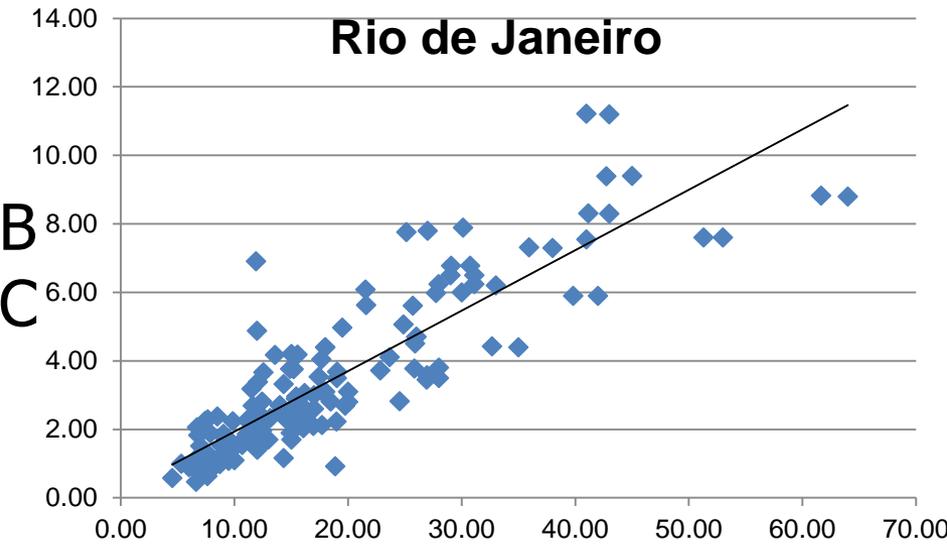
| | PM_{2.5} | Std Dev | Black Carbon | Std Dev | BC/PM_{2.5} |
|-----------------------|-------------------------|----------------|---------------------|----------------|----------------------------|
| São Paulo | 30 | 13 | 10 | 6 | 0.33 |
| Rio de Janeiro | 19 | 11 | 3 | 2 | 0.17 |
| Belo Horizonte | 17 | 7 | 5 | 3 | 0.28 |
| Porto Alegre | 16 | 12 | 4 | 4 | 0.22 |
| Curitiba | 17 | 8 | 4 | 3 | 0.27 |
| Recife | 12 | 3 | 2 | 1 | 0.17 |



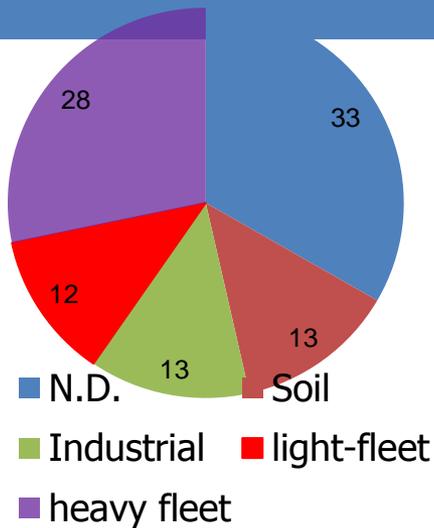


■ Curitiba
 ■ Rio Janeiro
 ■ Recife
 ■ São Paulo
 ■ Belo Horizonte
 ■ Porto Alegre

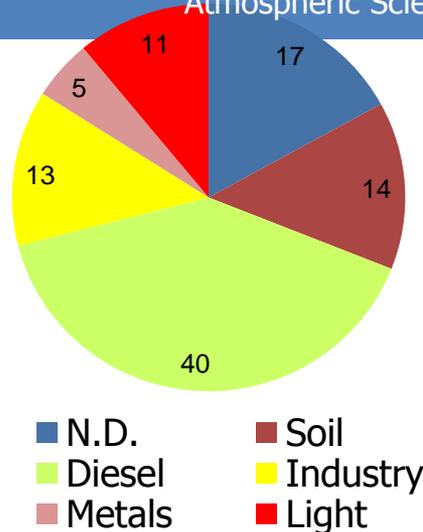
Ions composition



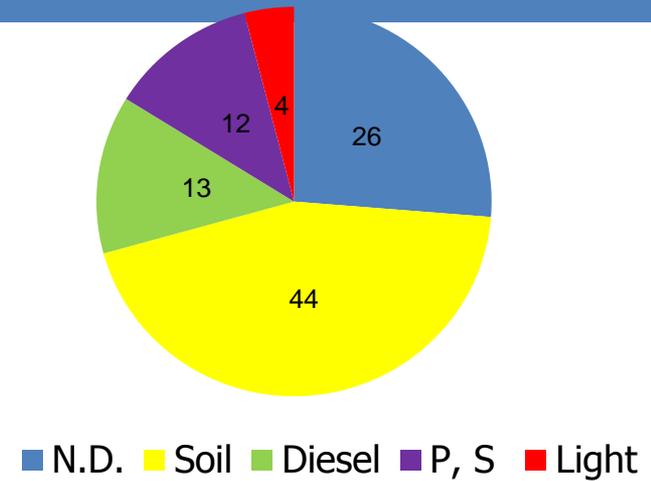
PM2.5



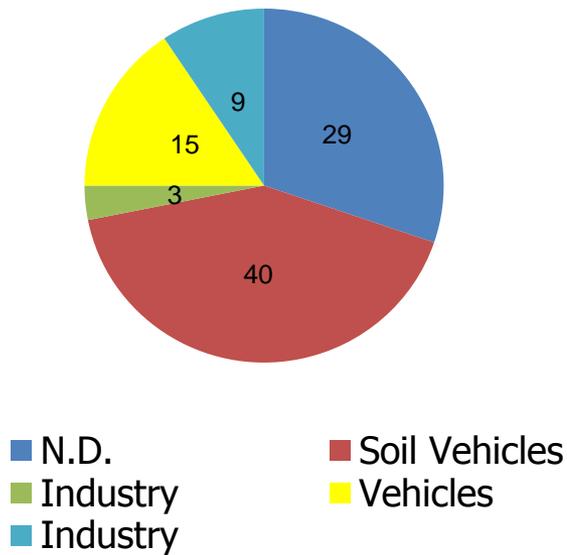
São Paulo



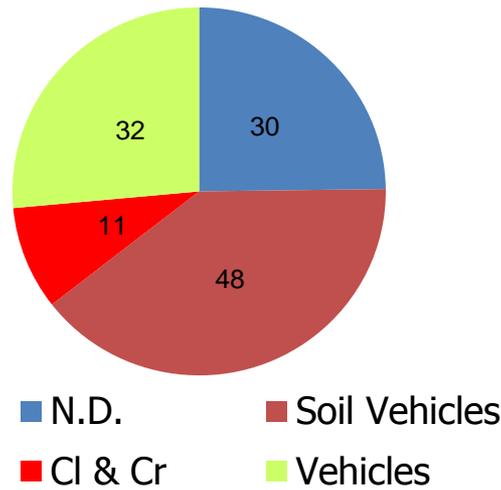
Rio de Janeiro



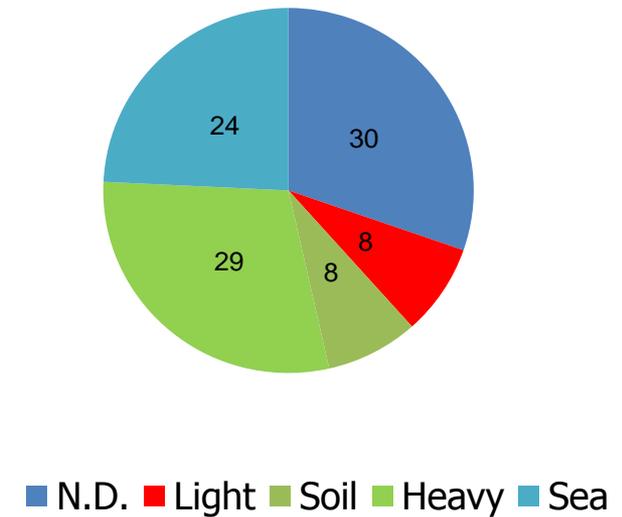
Belo Horizonte



Curitiba



Porto Alegre



Recife

Thank you!
Muchas gracias!
Obrigada!

