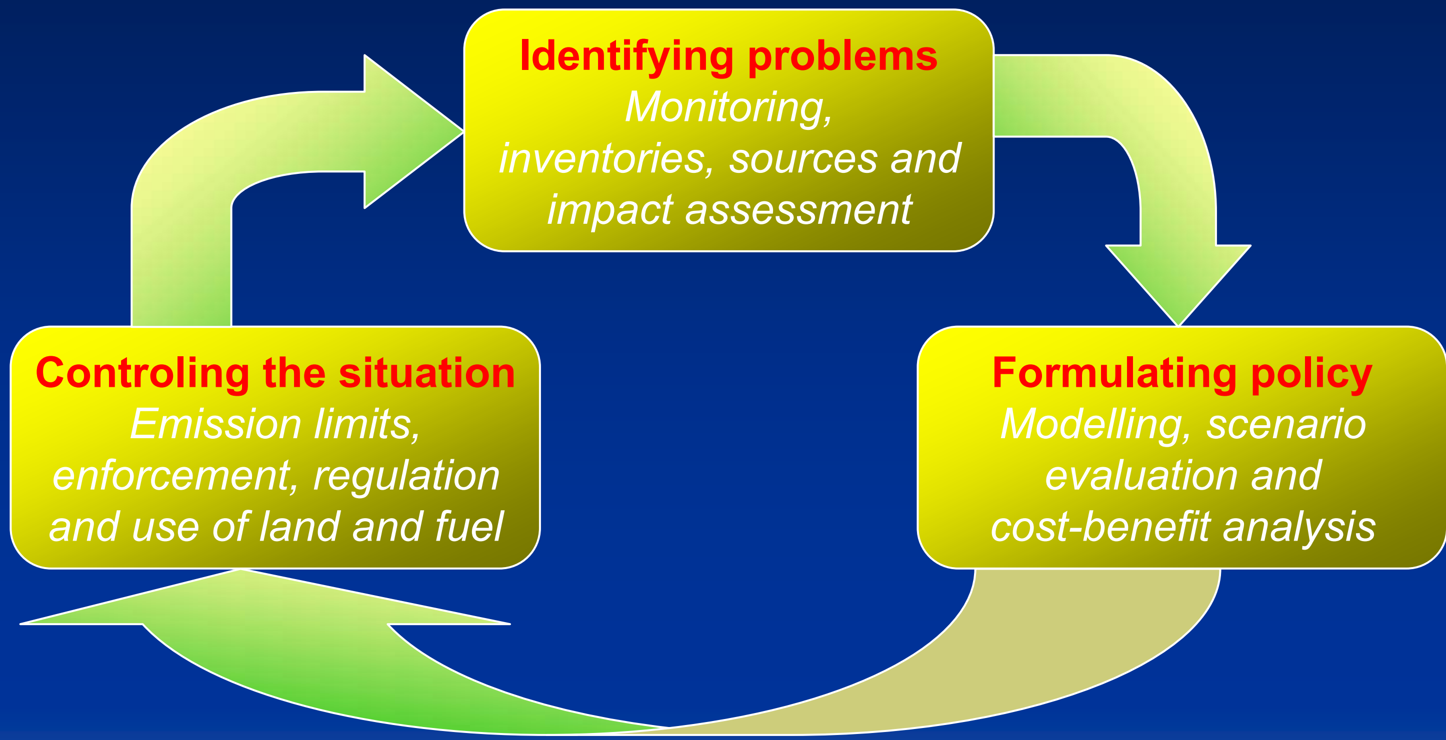
Centro Mario Molina • Chile

Seminario Internacional

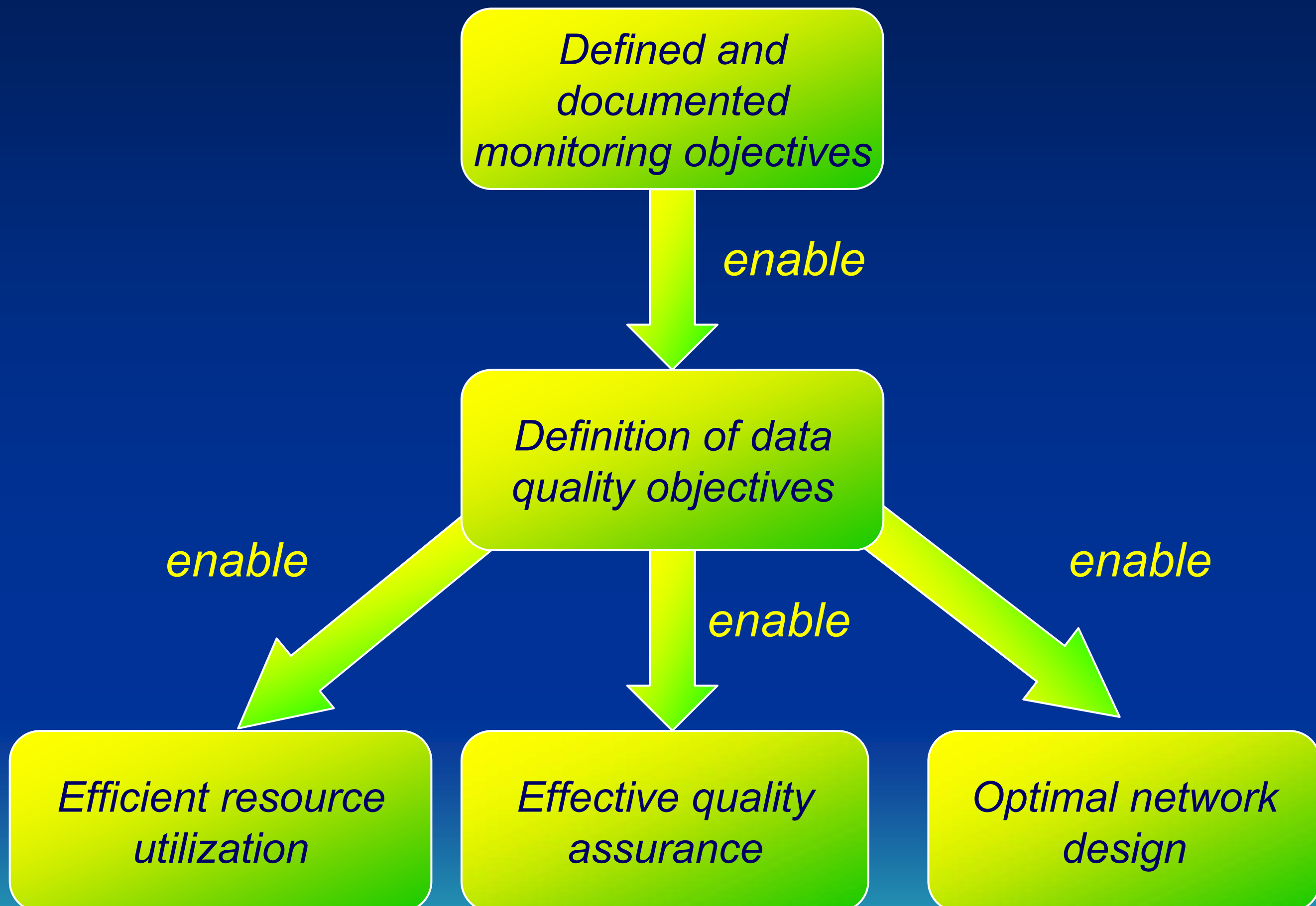
Hotel Radisson Plaza

Santiago Chile , 13 de Mayo 2008

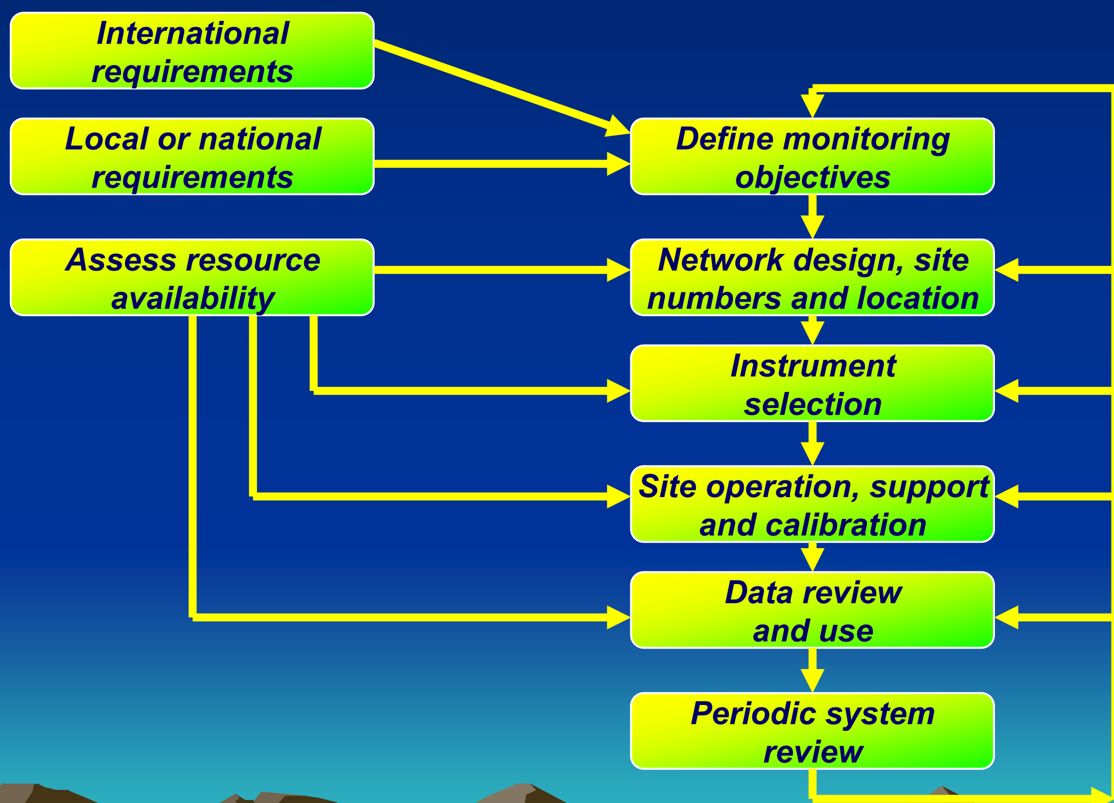
The role of monitoring in air quality management



The importance of setting objectives



Quality assurance and quality control for air quality monitoring: a step-by-step approach



Data flow in a monitoring programme

Raw data

↓ *Validation and ratification*

Reliable database

↓ *Analysis and interpretation*

Information

↓ *Reporting and dissemination*

Use

Data validation: some ground rules

- An ongoing front-end screening process
- Review all data
- Do it quickly
- Use printouts and graphs
- Common sense and experience are required
- Avoid excessive dependence on automatic systems

Possible monitoring locations relevant to exposure assessment

Site Clasification	Description
City or urban centers	An urban location representative of general population exposure in towns or city centers, such as pedestrian precincts and shopping areas
Urban background	And urban location removed from the sources of pollution and therefore broadly representative of city-wide background conditions
Suburban or residential	A location type situated in a residential area on the outskirts of a town or city
Curbside or near a road	A site sampling within 1-5 meters of a busy road
Industrial	An area where industrial sources make an important contribution a long-term or peak concentrations
Rural	An open countryside location as far away as possible from roads and populated and industrial areas
Other	Any special sources-oriented or microenvironment site or one located at a targeted receptor point, such as a school or hospital

Air monitoring methods

Method	Advantages	Disadvantages	Capital cost
Passive Samplers	Very low cost Very simple No dependence on mains electricity Can be deployed in very large numbers Useful for screening and baseline studies	Unproven for some pollutants In general, only provide monthly and weekly averages Labour-intensive deployment and analysis Not a reference method for monitoring compliance Slow data throughput	US $10 to $70 per sample
Active samplers	Low cost Easy to operate Reliable operation and performance Historical dataset	Provide daily averages Labour-intensive sample collection and analysis Laboratory analysis required Slow data throughput	About US $1000 to $3000 per unit
Automatic analyzers	Proven High performance Hourly data On-line information	Complex Expensive High skill requirement High recurrent costs	About US $10000 to $15000 per analyzer
Remote sensors	Provide path or range-resolved data Useful near sources Multi-component measurements	Very complex and expensive Difficult to support, operate, calibrate and validate Not readily comparable with point Not a reference method for compliance monitoring	About US $70000 to $150000 per sensor or more

Primary gas calibration methods and traceability

(+: appropriate method; –: not applicable)

Method	CO	SO_2	NO	NO_2	O_3	Comments on method Traceability
Commercial cylinder	+	-	-	-	-	Concentrations not assumed; must be checked by independent methods as appropriate
Permeation tubes	-	+	-	+	-	Absolute (weighing); commercial tubes may traceable to standards
Static dilution	+	+	+	+	-	Absolute method (volume)
Dynamic dilution	+	+	+	+	-	Dependent on cylinder and mass flow controller performance
Gas phase titration	-	-	+	-	+	Not absolute but comparative technique (O_3/ NO)
Ultraviolet photometry	-	-	-	-	+	Absolute method (ultraviolet absorption)

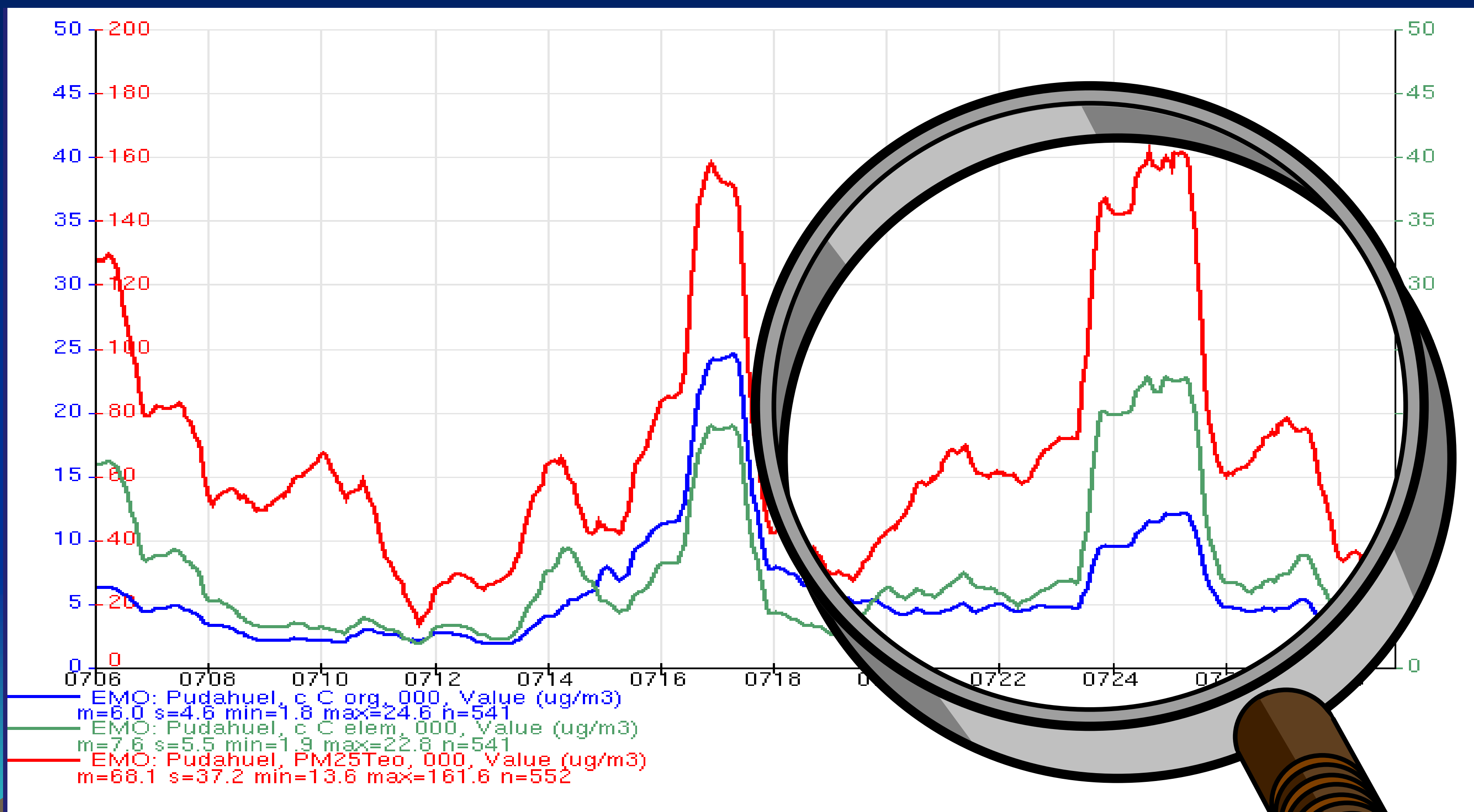
Network design: factors to consider in site location

- Major sources or emissions of pollutants in the area
- Target receptors and environments
- Weather and topography
- Model simulations of dispersion patterns in the area
- Existing air quality information (such as from screening studies)
- Data on demography, health and land use

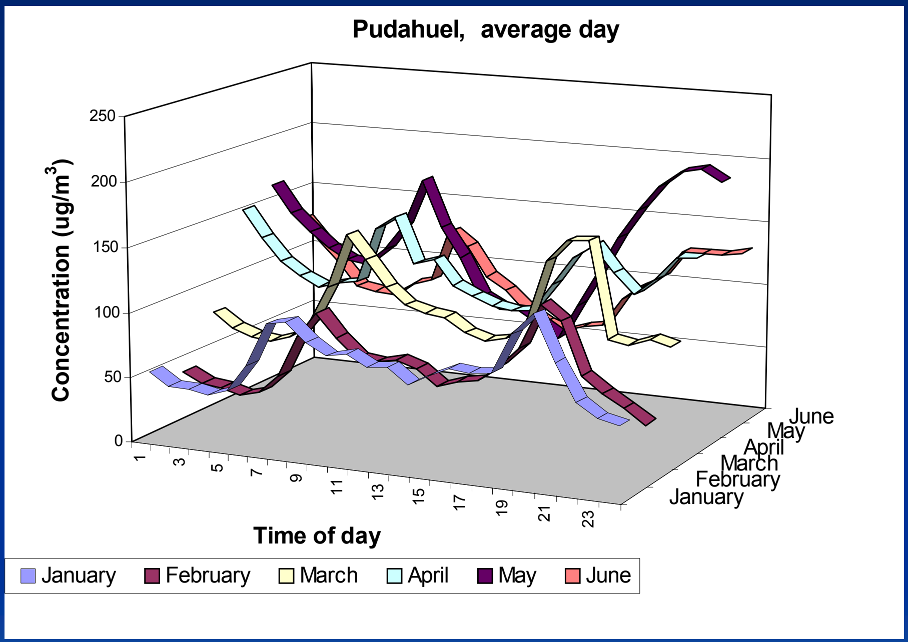
Small-scale considerations in site selection

- Public safety
- Site visibility
- Security and vandalism
- Access to utilities
- Planning permits
- Local sources or sinks
- Aerodynamic clearance or sheltering

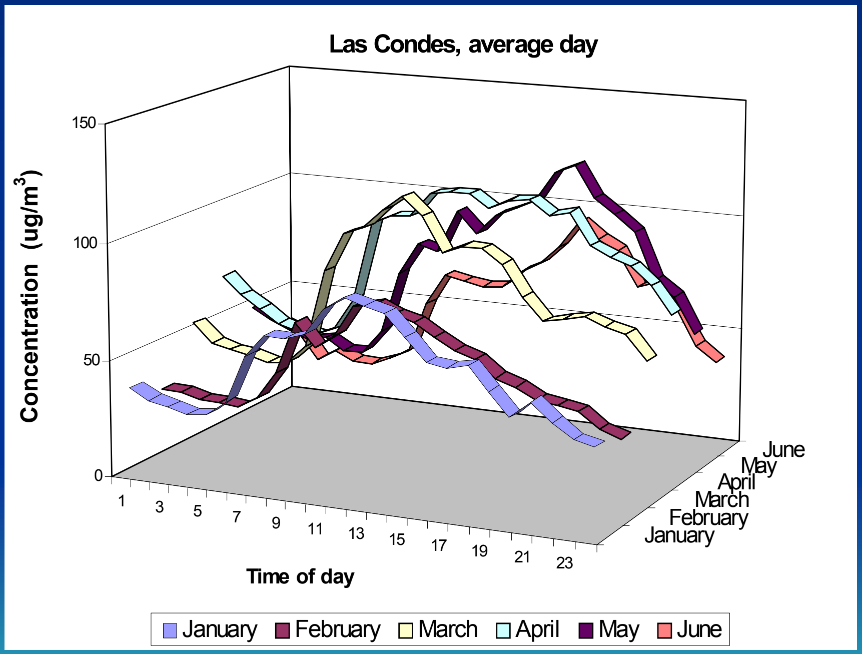
Episodio “Tipo A”



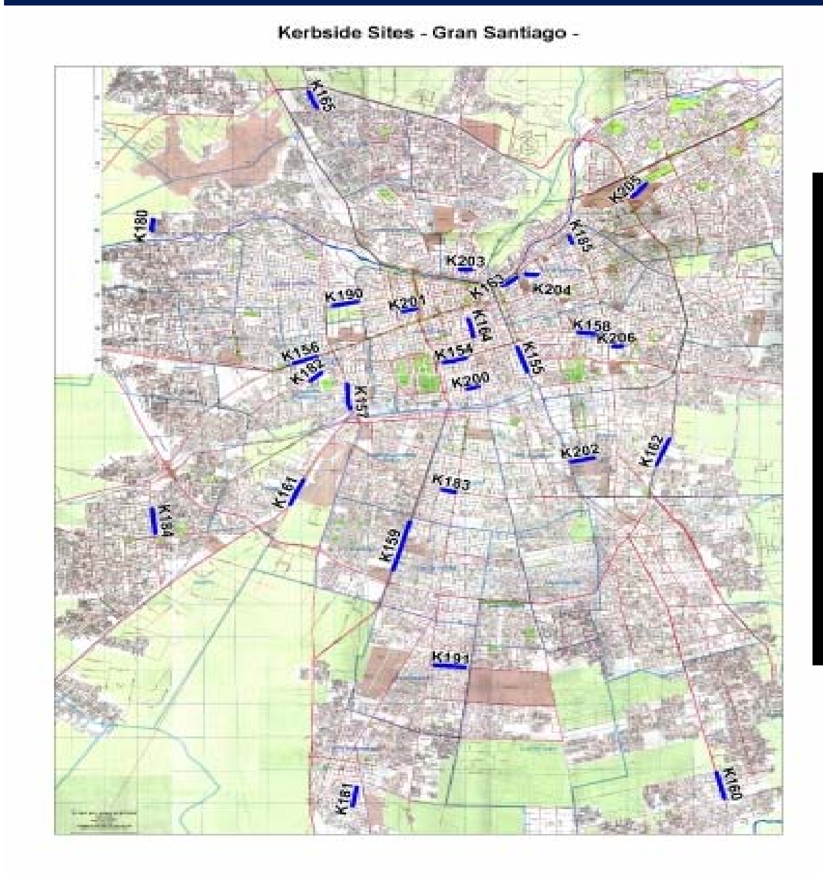
local traffic influence

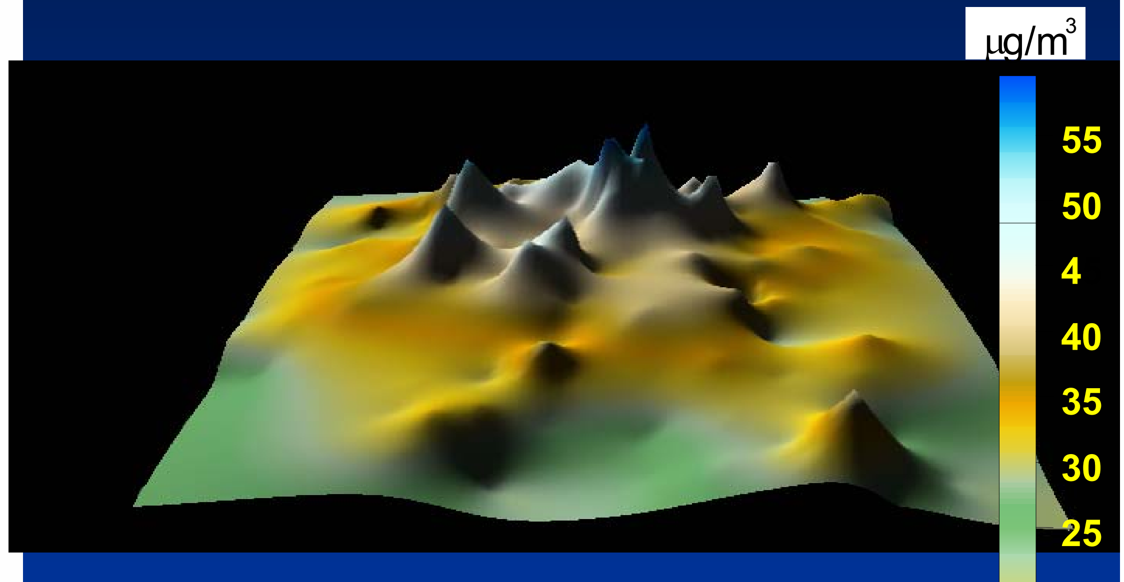


Without local traffic influence

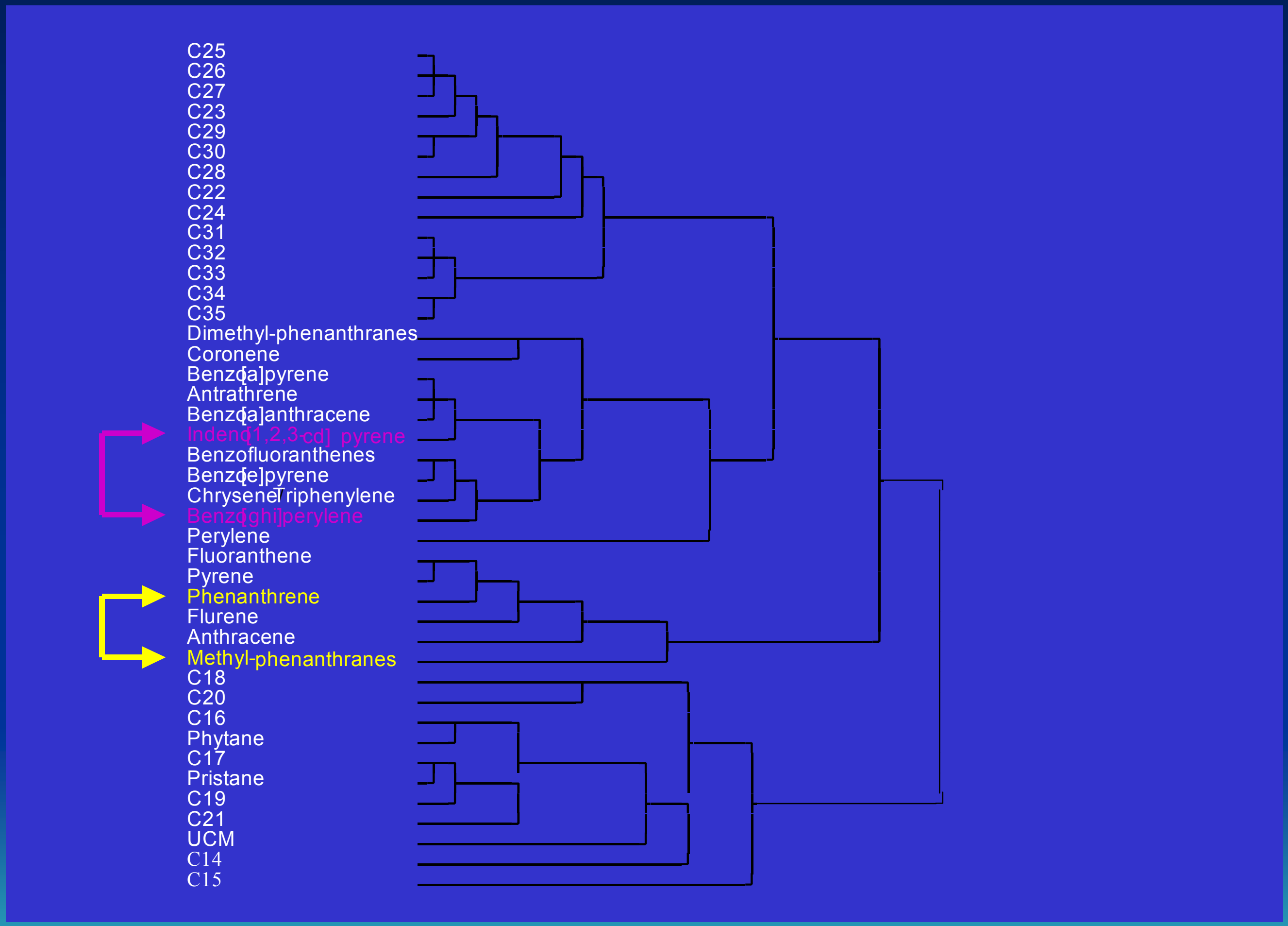


NO2 Passive Samplers, 2005

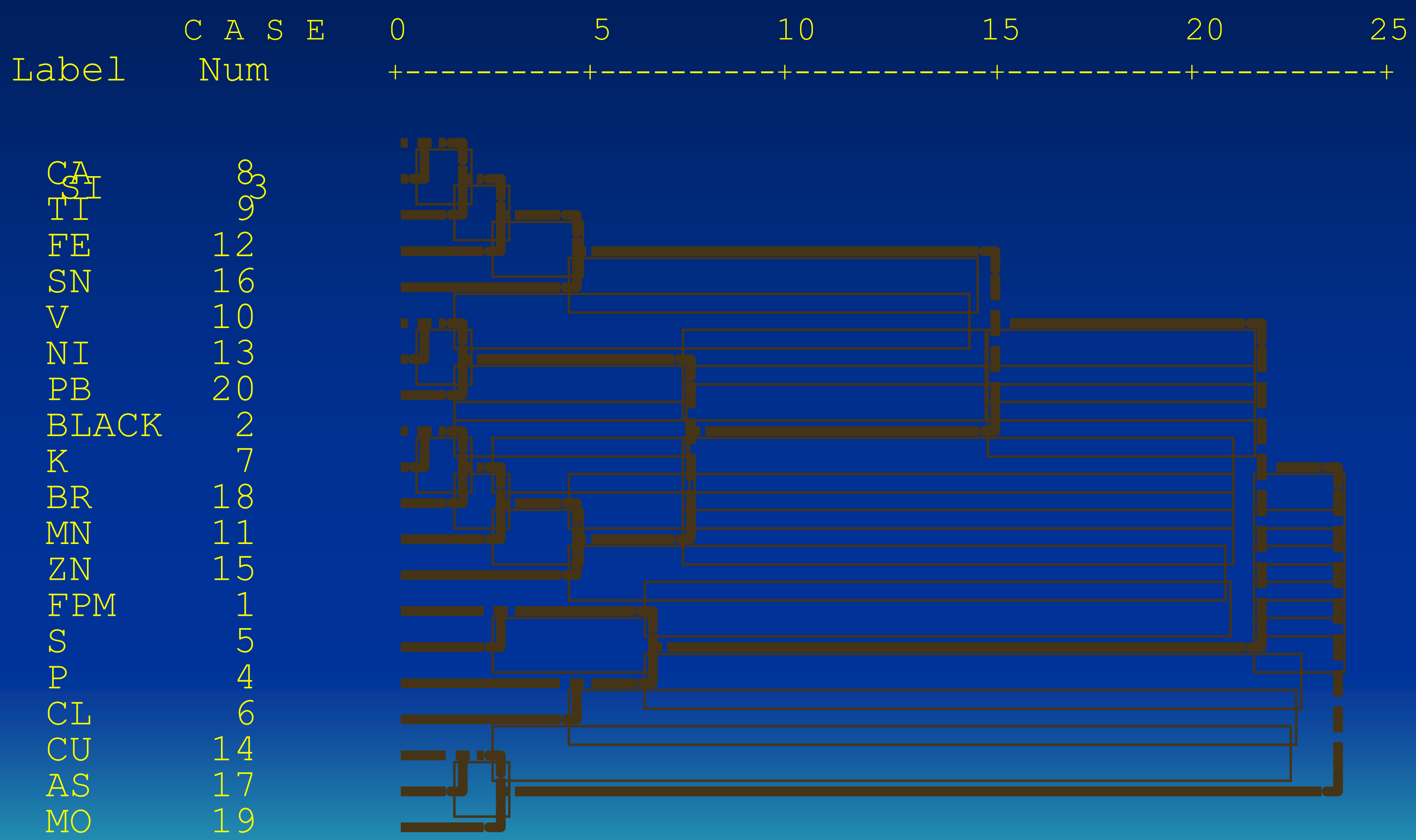




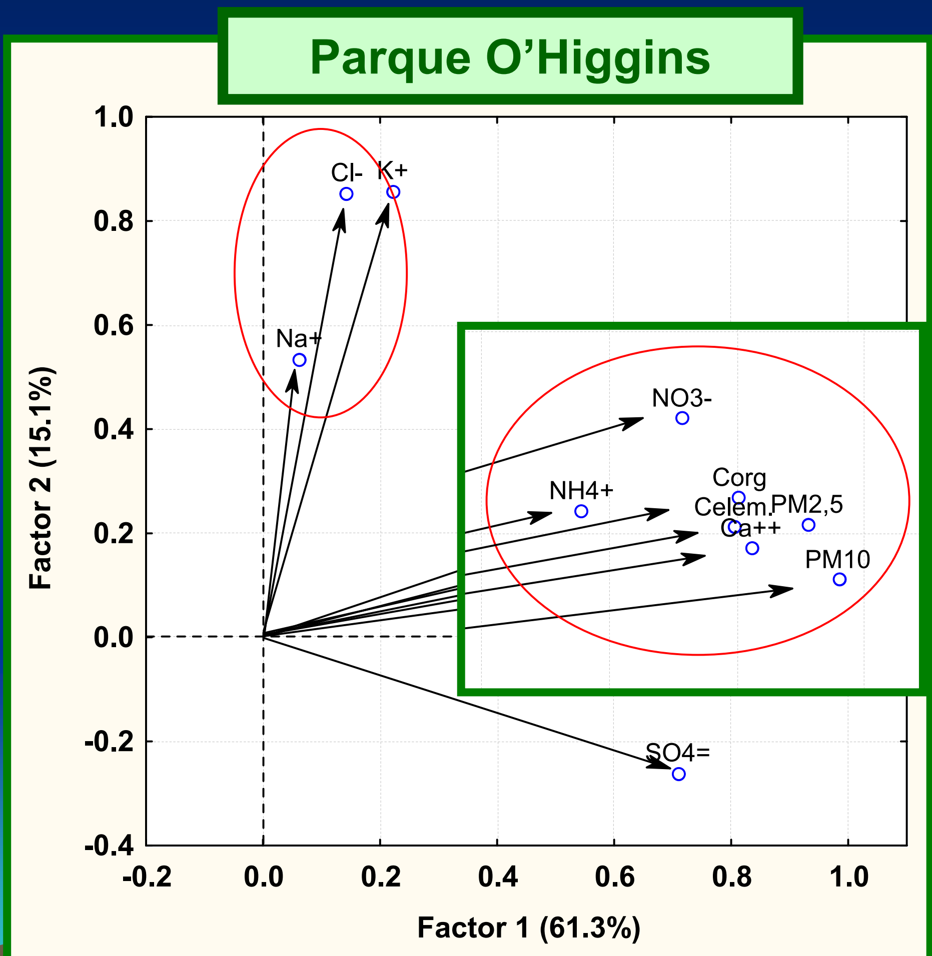
Clusters and Sources

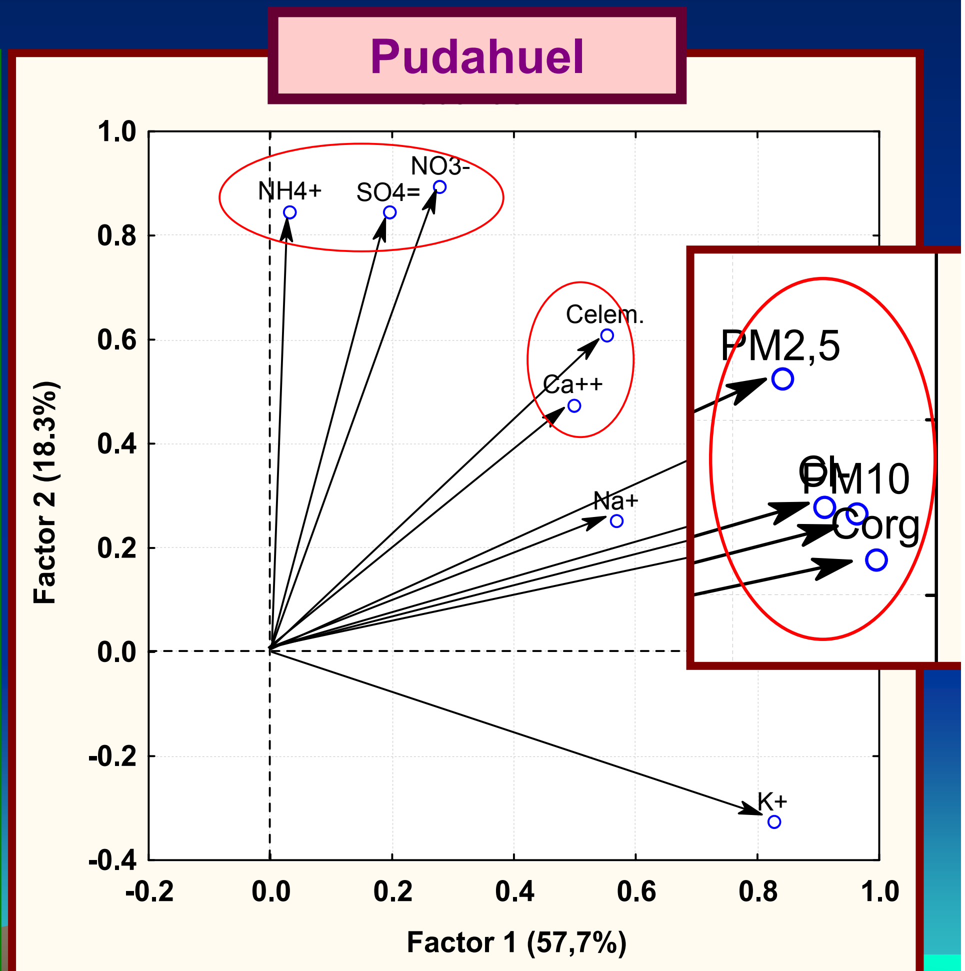


Clusters and Sources

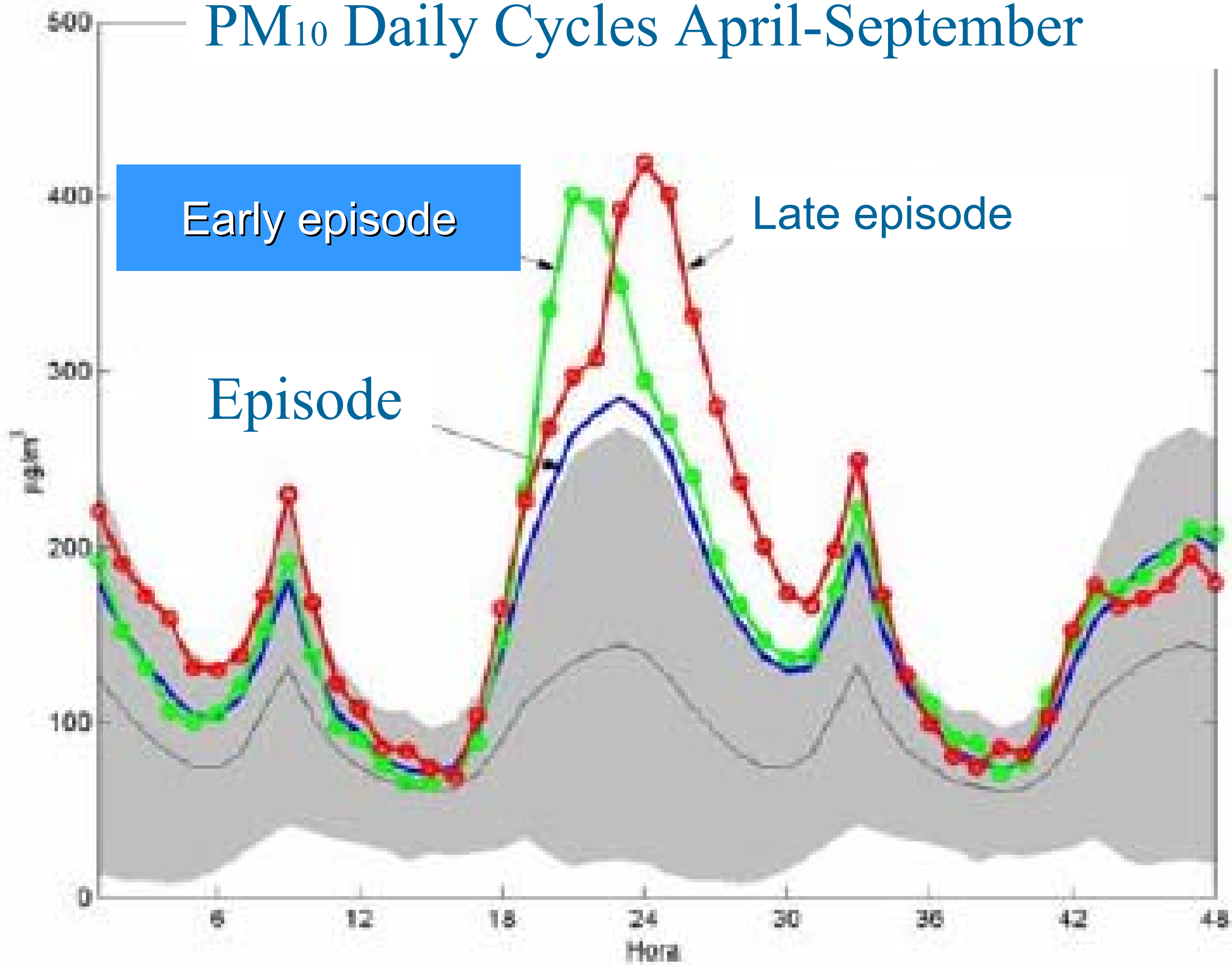


FACTORIAL ANALYSIS BY SPECIES - Charge of Factors 1 y 2 by Varimax Rotation

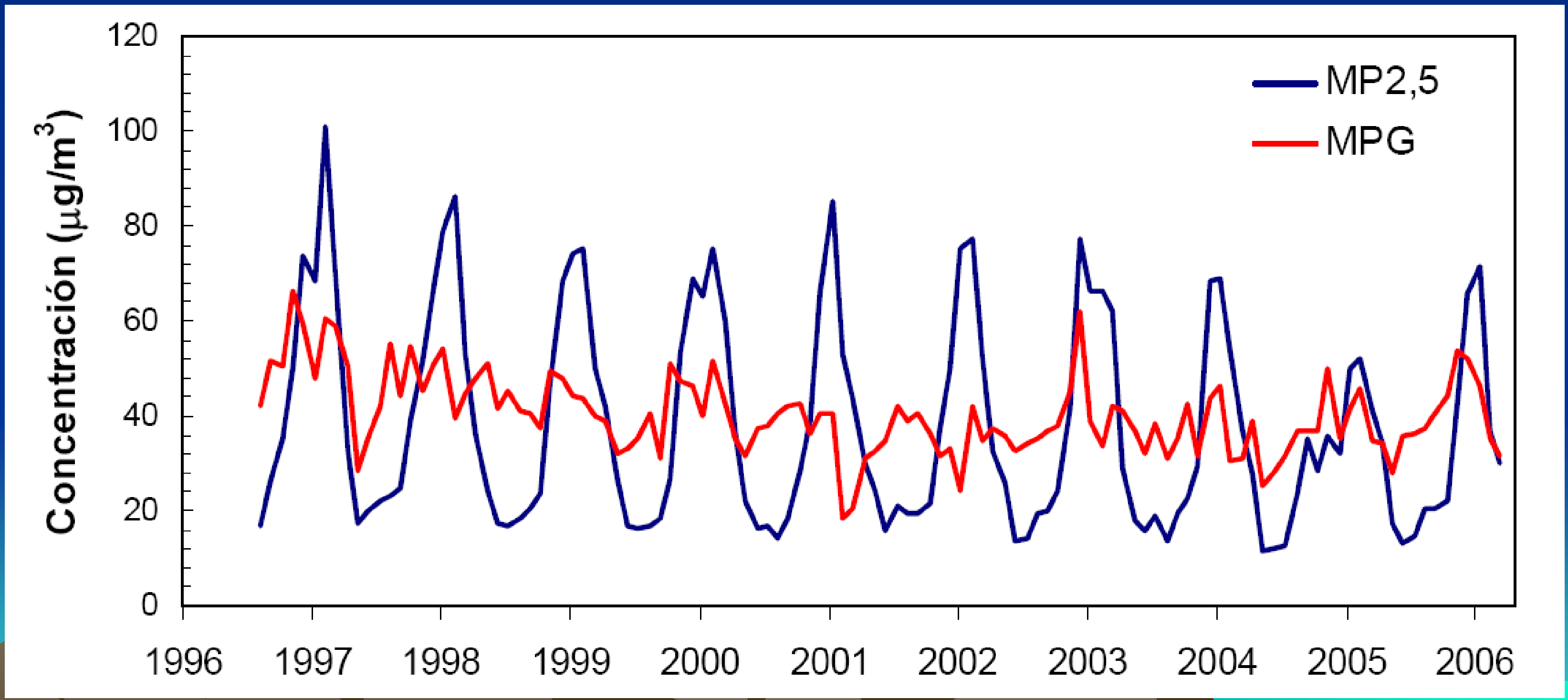




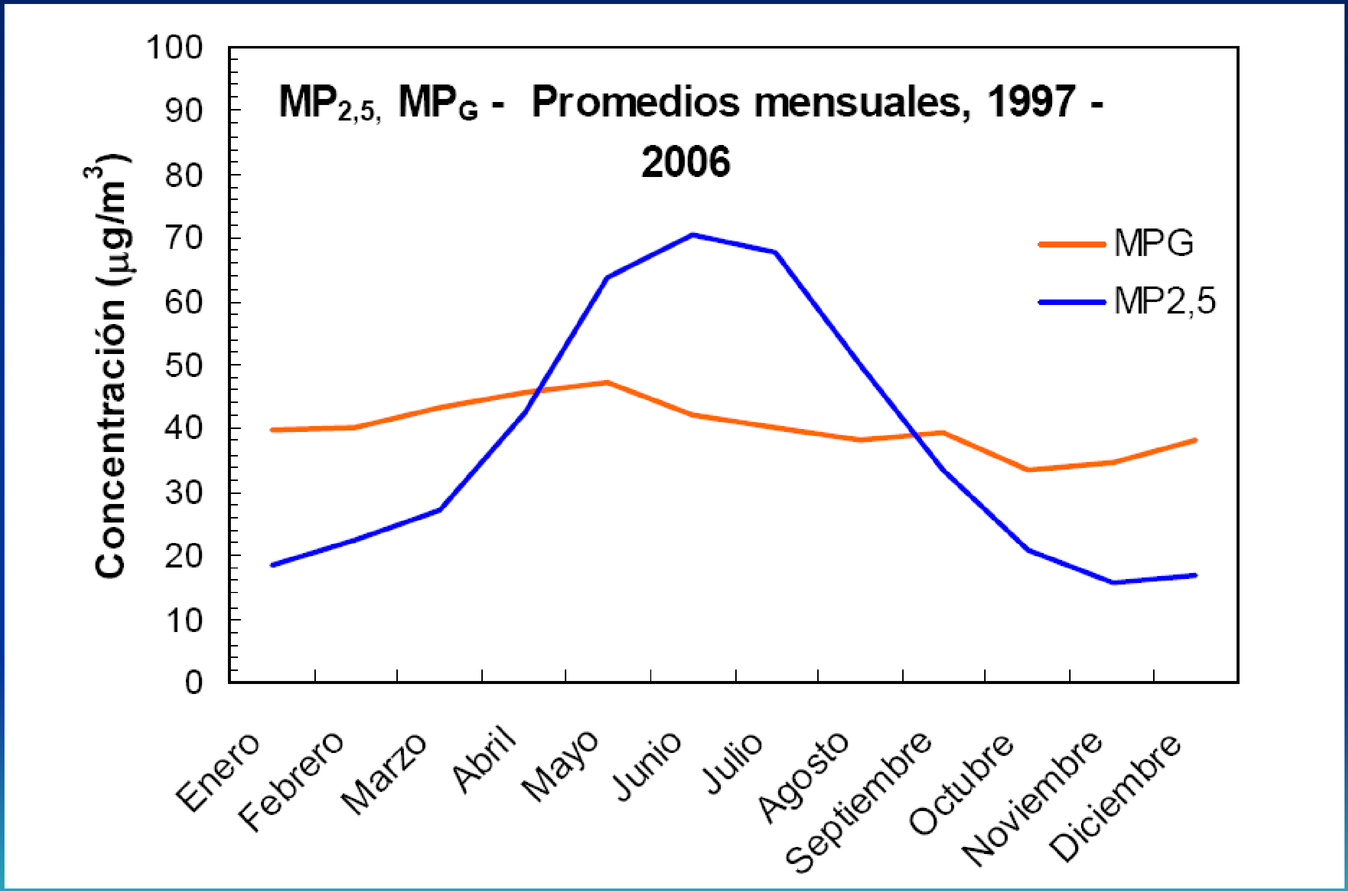
PM10 Daily Cycles April-September



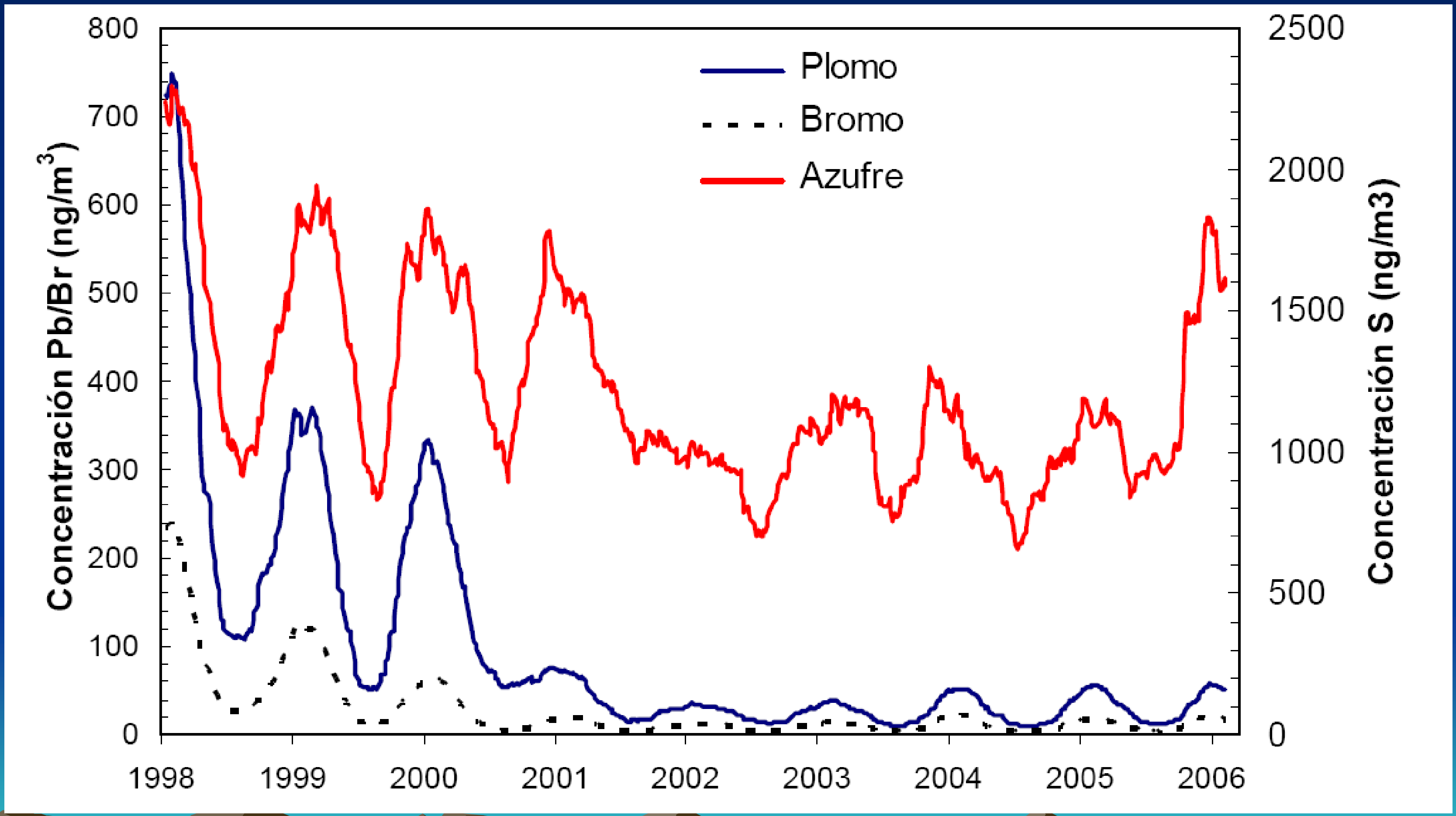
Promedio mensual de material particulado fino y grueso en Parque O'Higgins 1996 - 2006



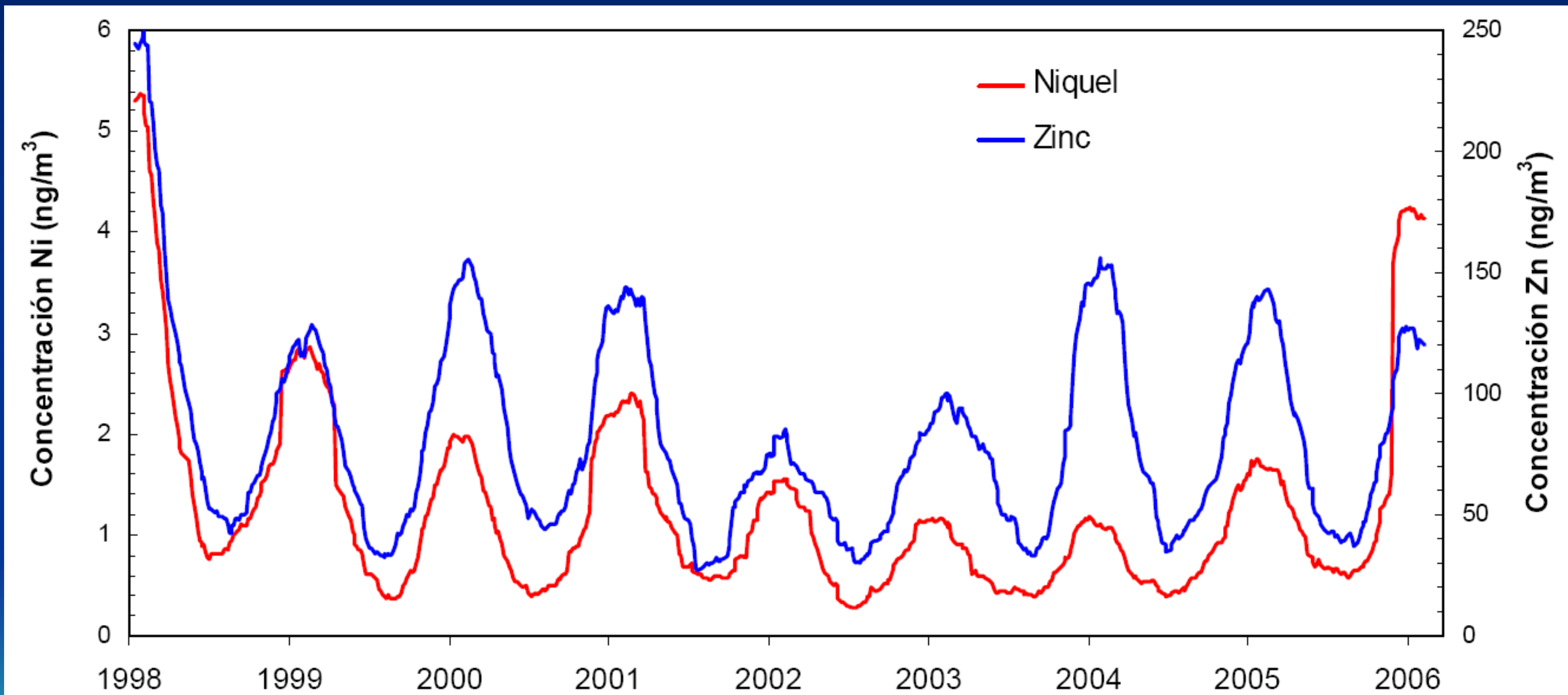
Promedios mensuales de material particulado fino y grueso en Parque O'Higgins entre los años 1997 y 2006



Media móvil de 30 puntos para plomo, bromo y azufre entre el 1 Abril 1998 y 31 Agosto 2006



Media móvil de 30 puntos para níquel y zinc entre el 1 Abril 1998 y 31 Agosto 2006



PM10 and O3 Cluster Analysis, 2000

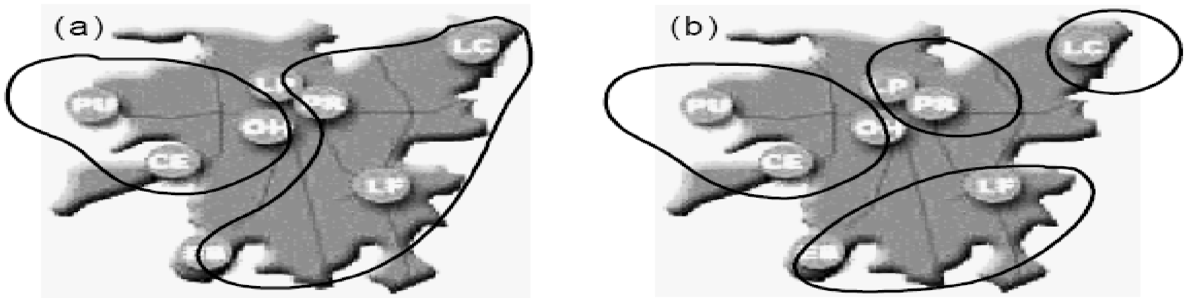


Figure 10. a) Clustering of the city into two groups when $R_i = 0.72$. b) Clustering into four groups when $R_i = 0.86$. The analysis was performed with PM10 data.

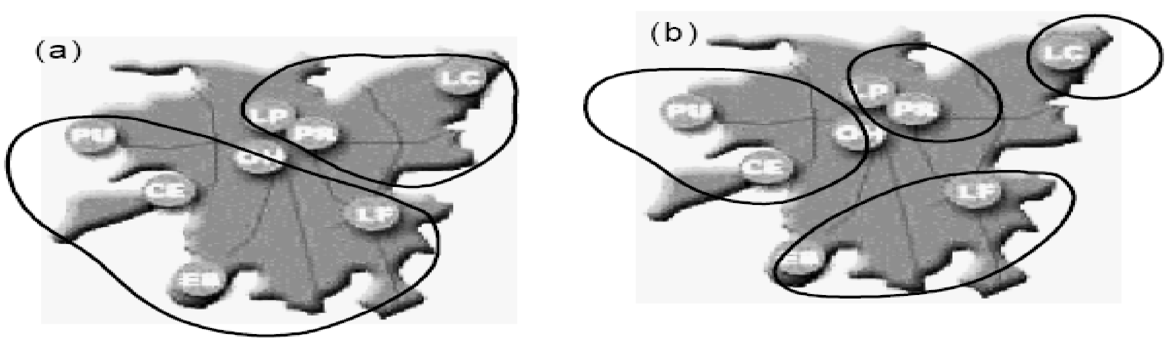


Figure 11. a) Clustering of the city into two groups when $R_i = 0.909$. b) Clustering into four groups when $R_i = 0.956$. The analysis was performed with O_3 data.

Correlation R^2 (% variance)

	F	L	M	N	O	P	Q	R
La Florida (F)	**1,00**	**0,80**	0,51	**0,87**	0,61	0,80	0,80	0,75
La Paz (L)	**0,80**	**1,00**	0,60	**0,81**	0,60	0,73	**0,84**	0,70
Las Condes (M)	0,51	0,60	**1,00**	0,43	0,23	0,38	0,44	0,28
Parque O'Higgins (N)	**0,87**	**0,81**	0,43	**1,00**	0,67	**0,88**	**0,86**	**0,84**
Pudahuel (O)	0,61	0,60	0,23	0,67	**1,00**	0,71	0,66	**0,81**
Cerrillos (P)	0,80	0,73	0,38	**0,88**	0,71	**1,00**	**0,85**	**0,86**
El Bosque (Q)	0,80	**0,84**	0,44	**0,86**	0,66	**0,85**	**1,00**	**0,80**
Cerro Navia (R)	0,75	0,70	0,28	**0,84**	**0,81**	**0,86**	**0,80**	**1,00**

Bold: over 0,8

Factor Analysis

	Factor 1	Factor 2	(%) Variability 2 factors
La Florida (F)	0,76	0,58	90,9
La Paz (L)	0,70	0,66	92,4
Las Condes (M)	0,26	**0,95**	96,0
Parque O'Higgins (N)	0,84	0,48	94,1
Pudahuel (O)	**0,91**	0,21	87,1
Cerrillos (P)	0,87	0,42	93,2
El Bosque (Q)	0,82	0,51	92,1
Cerro Navia (R)	**0,93**	0,29	95,4

- **VARIMAX Rotation**
- **2 factors explain 93% of the variability at 8 sites**

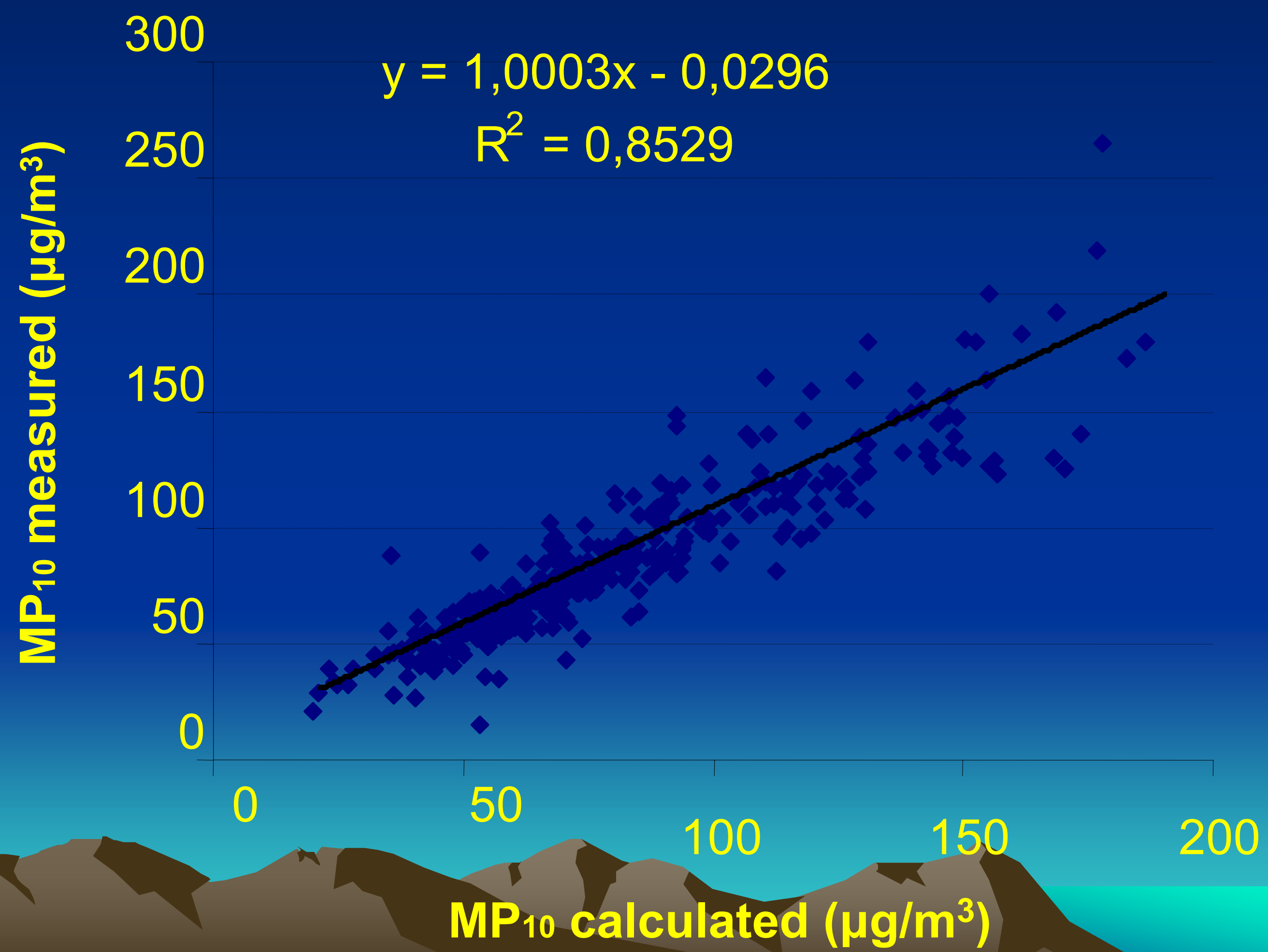
2 Sites Prediction

- Cerro Navia (R) and Las Condes (M)
- Represent 2 areas of influence
- Regression analysis

$$Site = \beta_0 + \beta_1 R + \beta_2 M$$

2 Sites Prediction (M y R)

El Bosque = 0,64+0,50 Las Condes +0,70 Cerro Navia



2 Sites Prediction (M y R)

Site	Interception	Las Condes	Cerro Navia	R2
La Florida (F)	4,4	0,61	0,56	0.83
La Paz (L)	-6,1	0,82	0,52	0.85
Parque O'Higgins (N)	-2,8	0,45	0,73	0.88
Pudahuel (O)	1,2	0,01	0,95	0.81
Cerrillos (P)	2,2	0,32	0,72	0.88
El Bosque (Q)	0,6	0,50	0,70	0.85

Fine particles size distribution

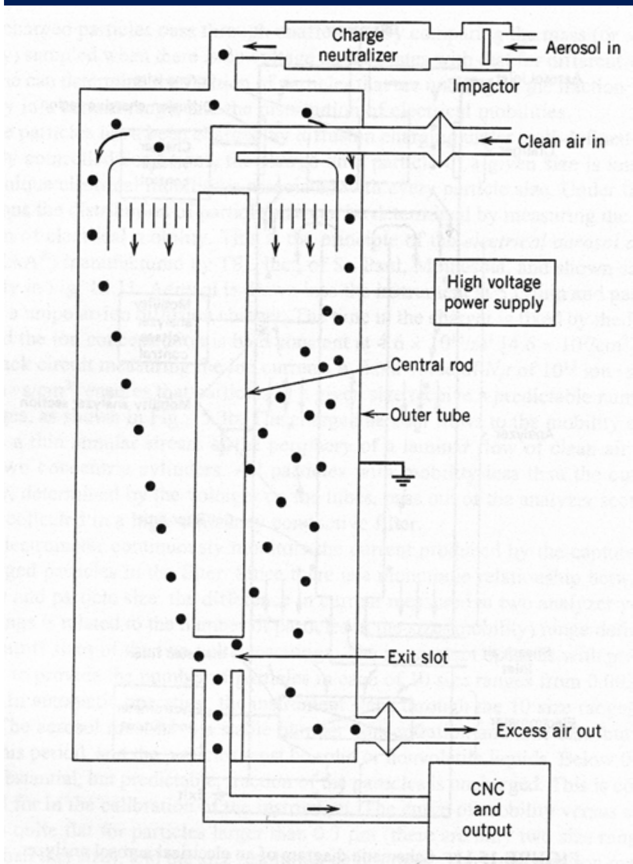
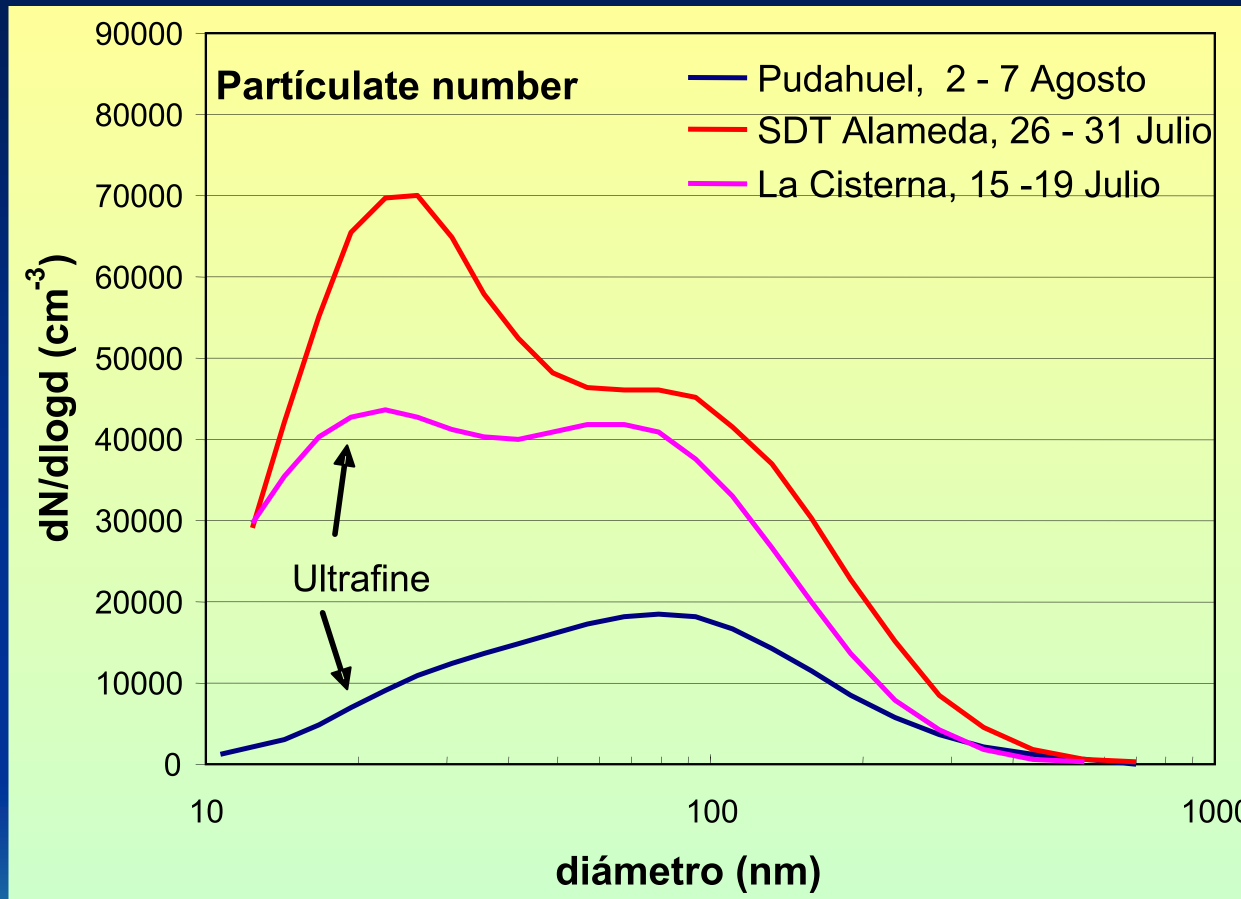


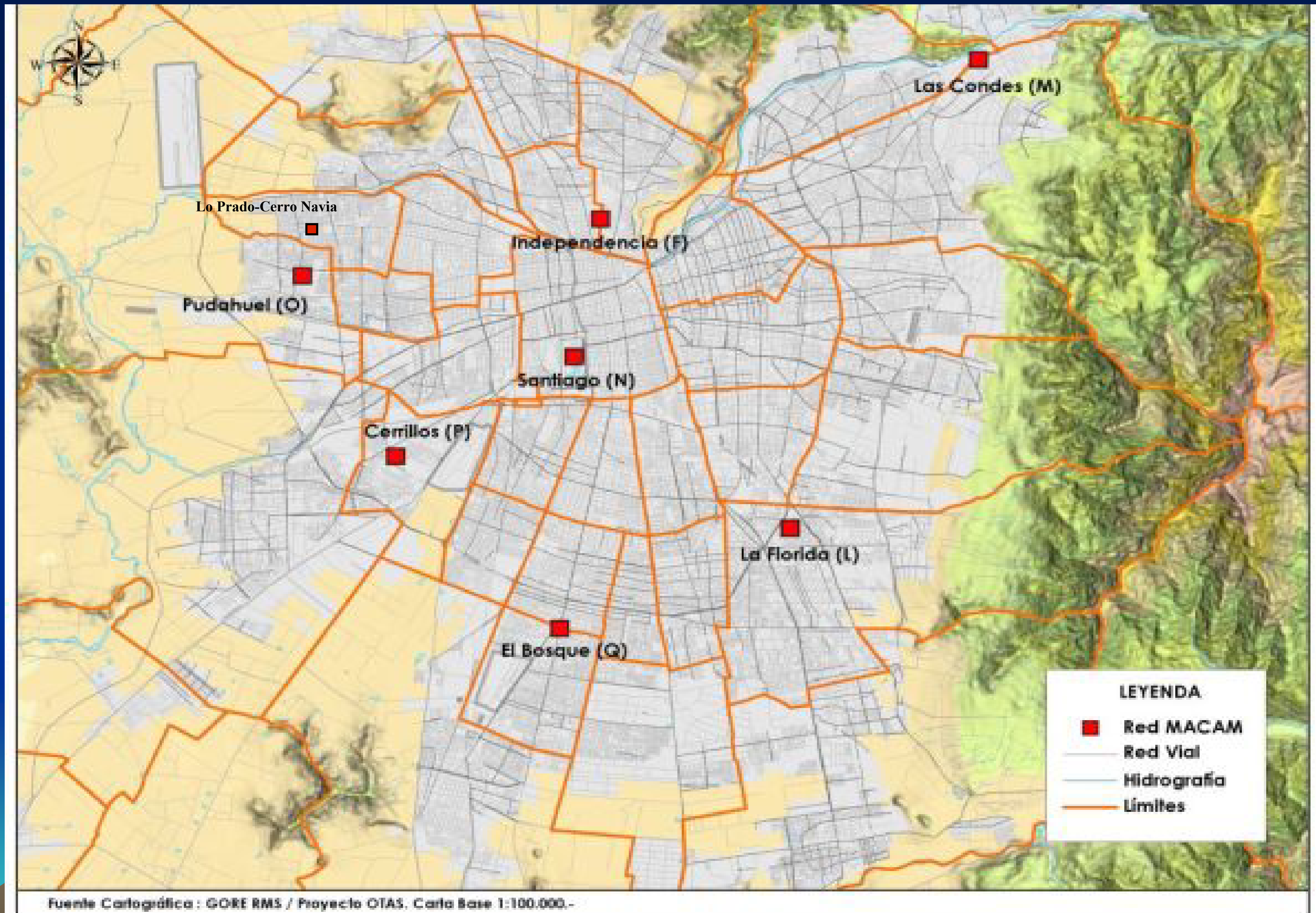
FIGURE 15.12 Schematic diagram of a differential mobility analyzer.

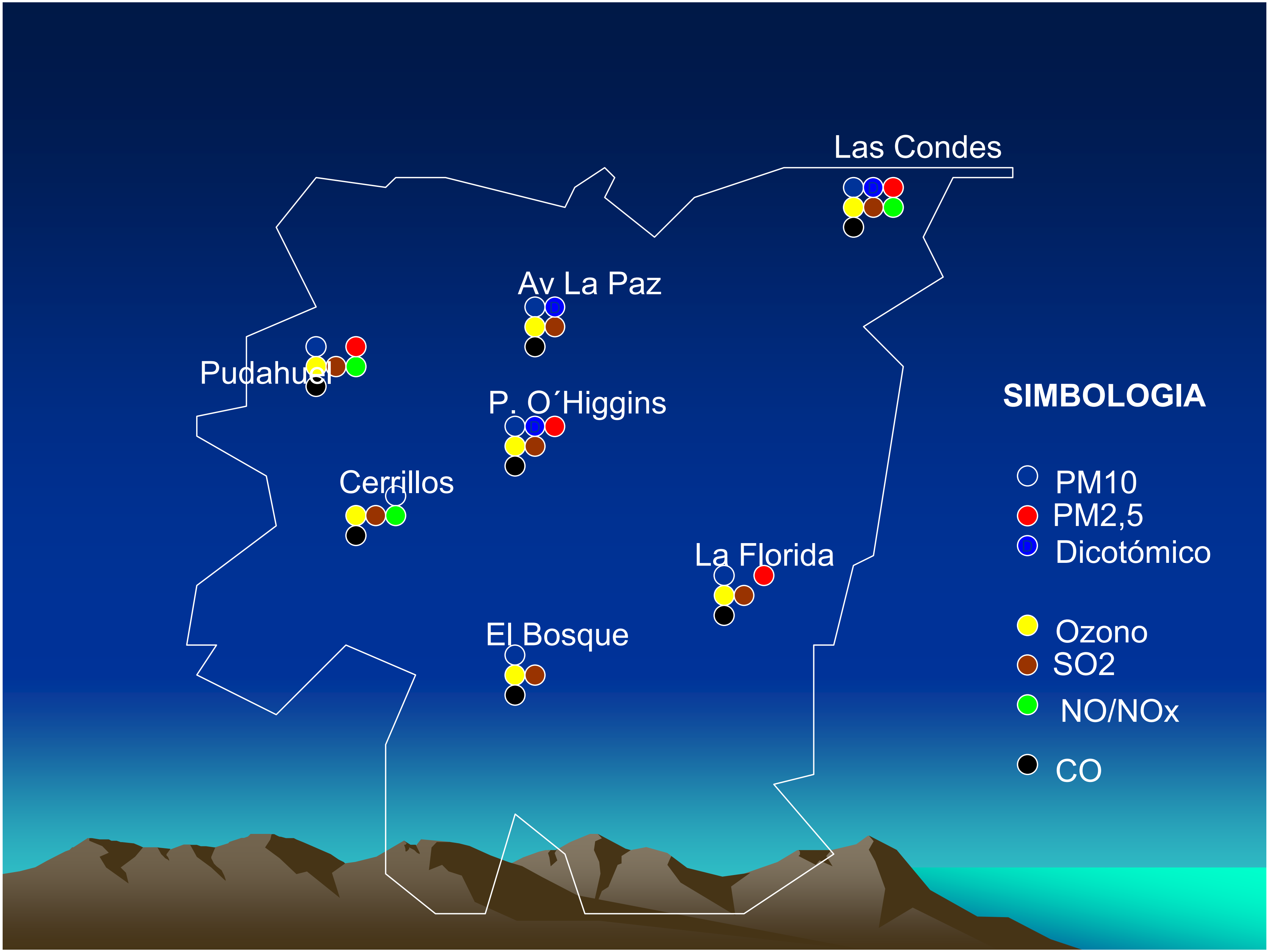


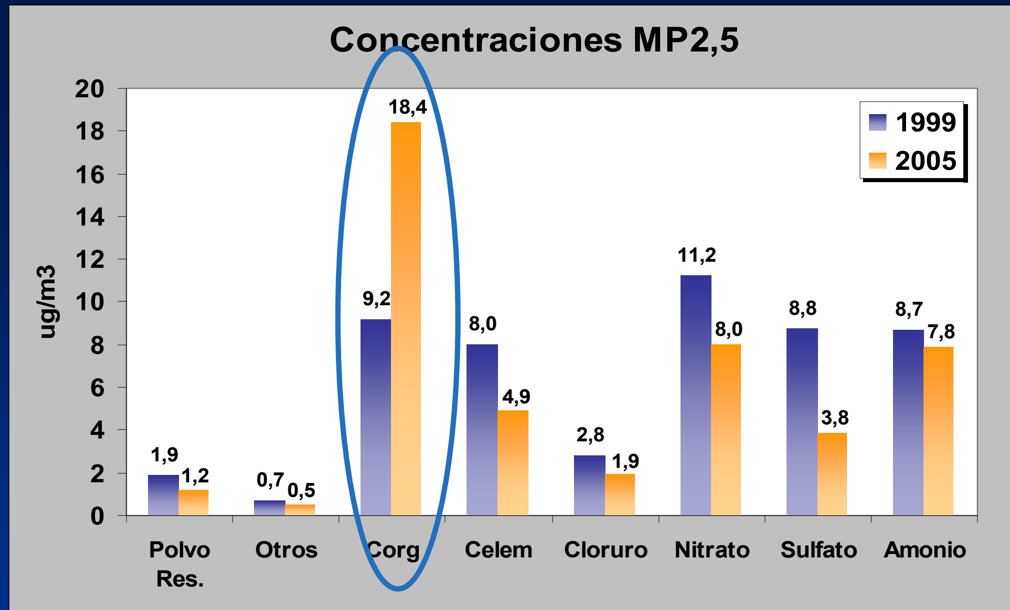
SDT Alameda: high traffic density **Pudahuel:** far from the street

La Cisterna: medium traffic density

MACAM II NETWOK 2006



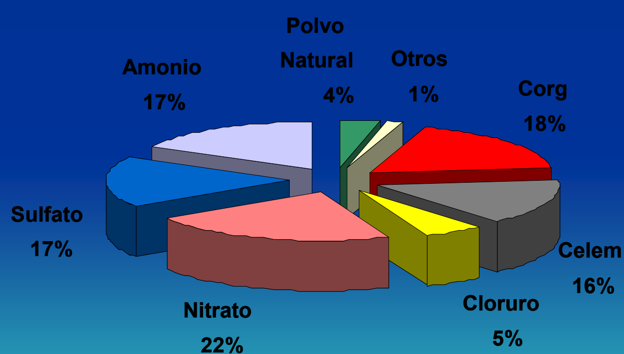

Las Condes
Av La Paz
Pudahuel
P. O´Higgins
Cerrillos
La Florida
El Bosque
SIMBOLOGIA
PM10
PM2,5
Dicotómico
Ozono
SO2
NO/NOx
CO



Concentración (ug/m³) Fracción PM2.5

SANTIAGO Invierno 1999

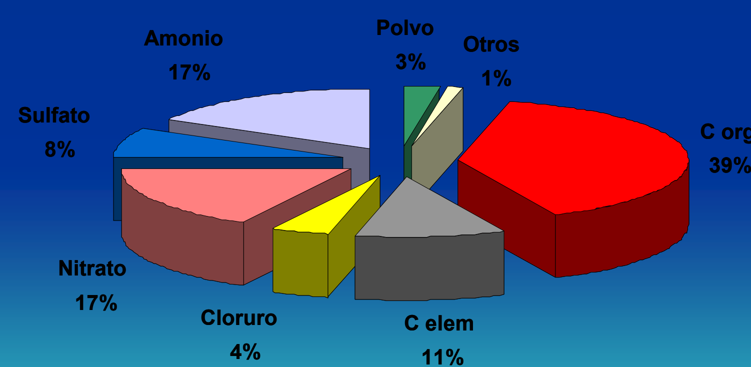
Concentración Promedio Total= 51,1 ug/m3



Concentración (ug/m3) Fracción MP2.5

SANTIAGO Invierno 2005

Concentración Promedio Total= 46,5 ug/m3



Distinción principal

Objetivos de diseño de red

Enfoque de clasificación de estaciones

CRITERIO 1: Gestión de episodios / contaminantes criterio normados

Características: Ubicación en areas residenciales
Contaminantes criterio (prioridad PM)
Equipamiento concebido como monitoreo permanente
Near real time

Producto: Información procesada y validada para gestión episodios (información y pronóstico)

Indicadores de evolución contaminantes criterio

CRITERIO 2: Gestión PPDA Largo Plazo (estudios y medidas sectores)

Comprensión fotoquimica

Comportamiento contaminación (tendencias, modelación…)

Cambio emisiones fuentes

Características: Ubicación diseñada para comprensión de fenómenos
Contaminantes + allá de criterio
Equipamiento concebido como campañas (Super Site…)
No necesariamente Near real time

Producto: Análisis e interpretación de resultados (orientados a comprensión de fenómenos y diseño de medidas)

CONSIDERACIONES DE PRIORIDAD

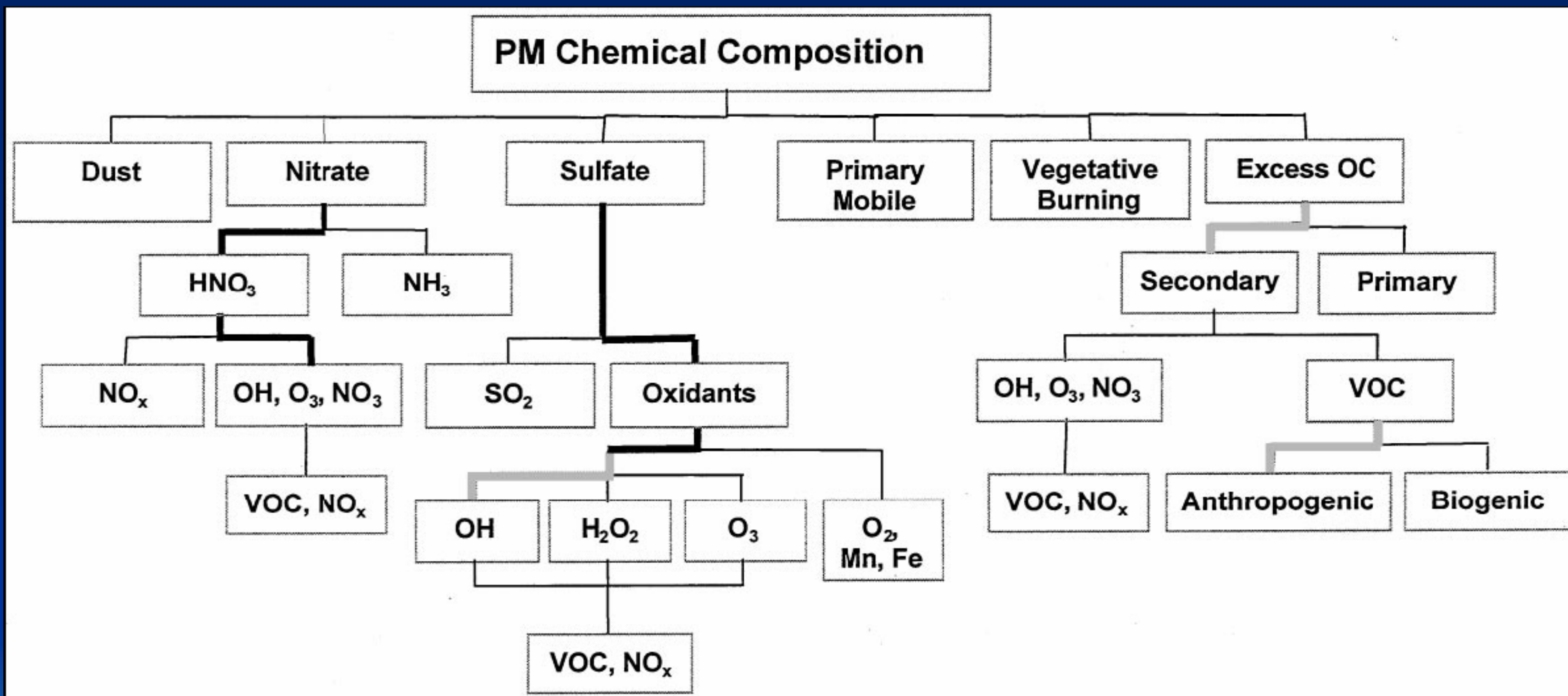
UBICACIÓN

FLEXIBILIDAD / CAPACIDAD

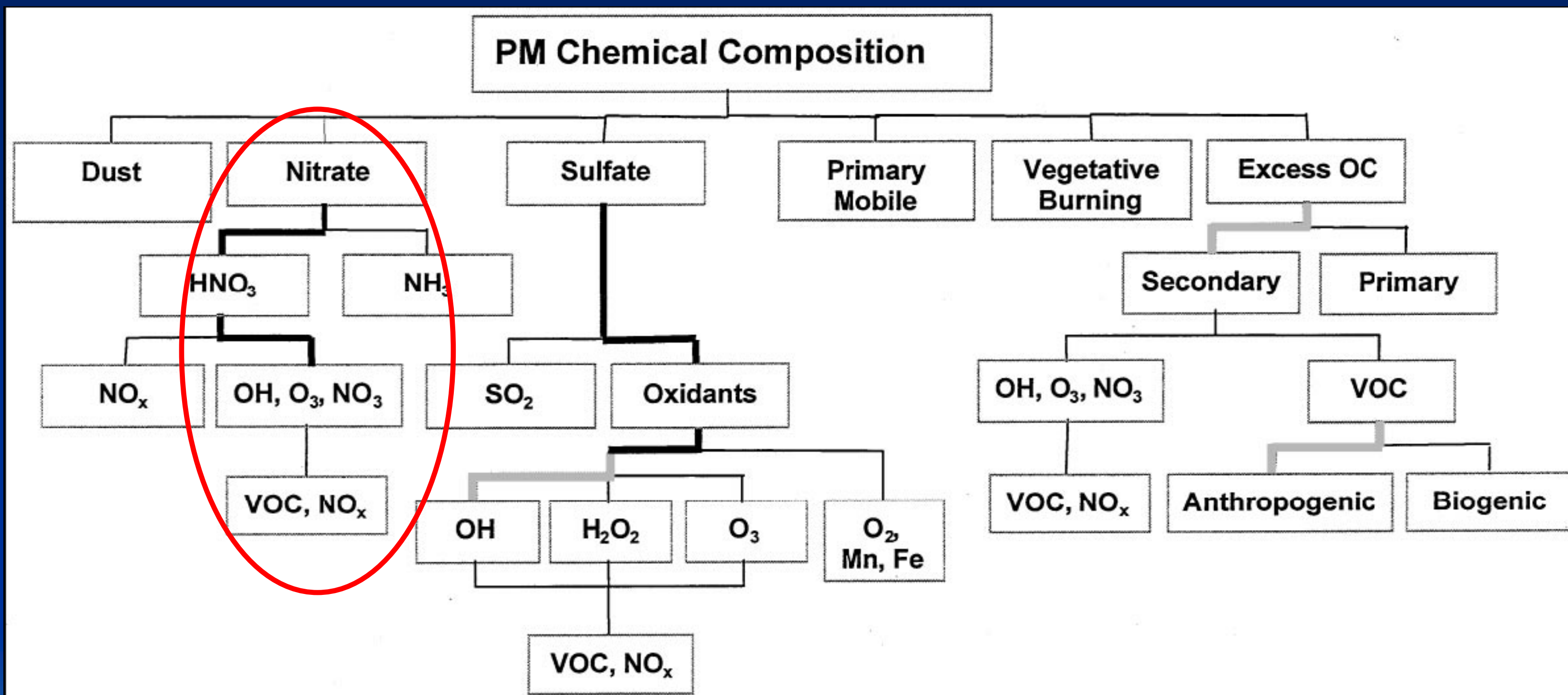
CONTAMINANTES NORMADOS NECESARIOS

ANALISIS E INTERPRETACION
(usando analisis de factores principales absolutos, análisis de cluster, contribución de fuentes, modelo receptor, etc.)

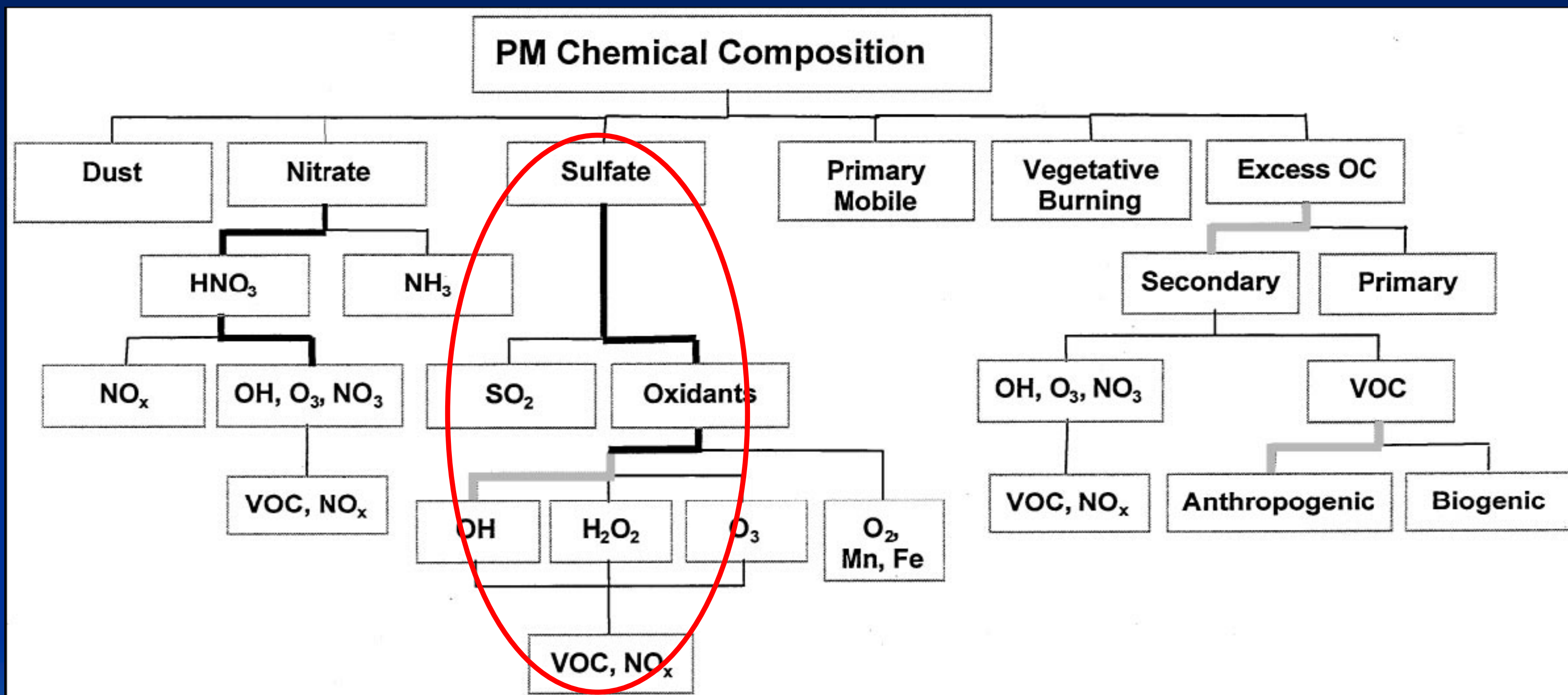
PM precursors



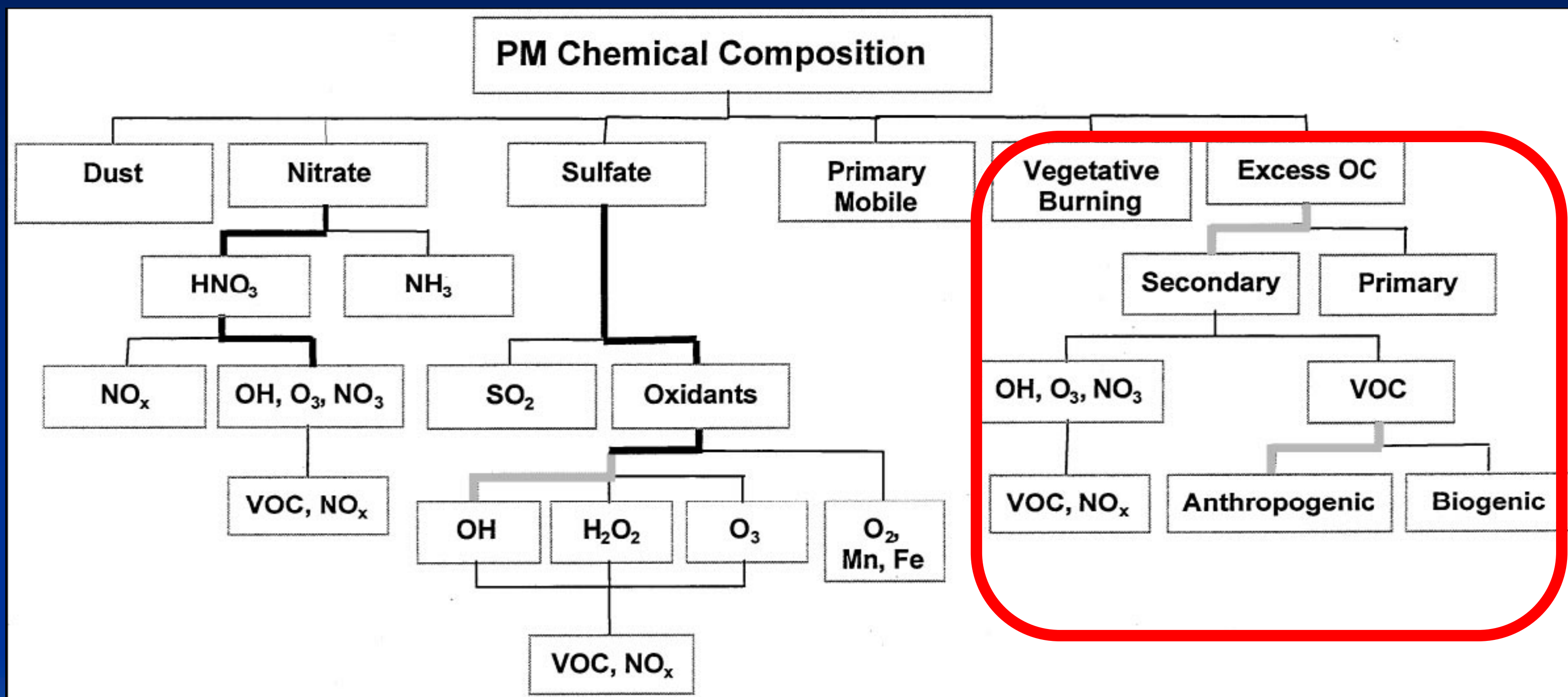
PM precursors



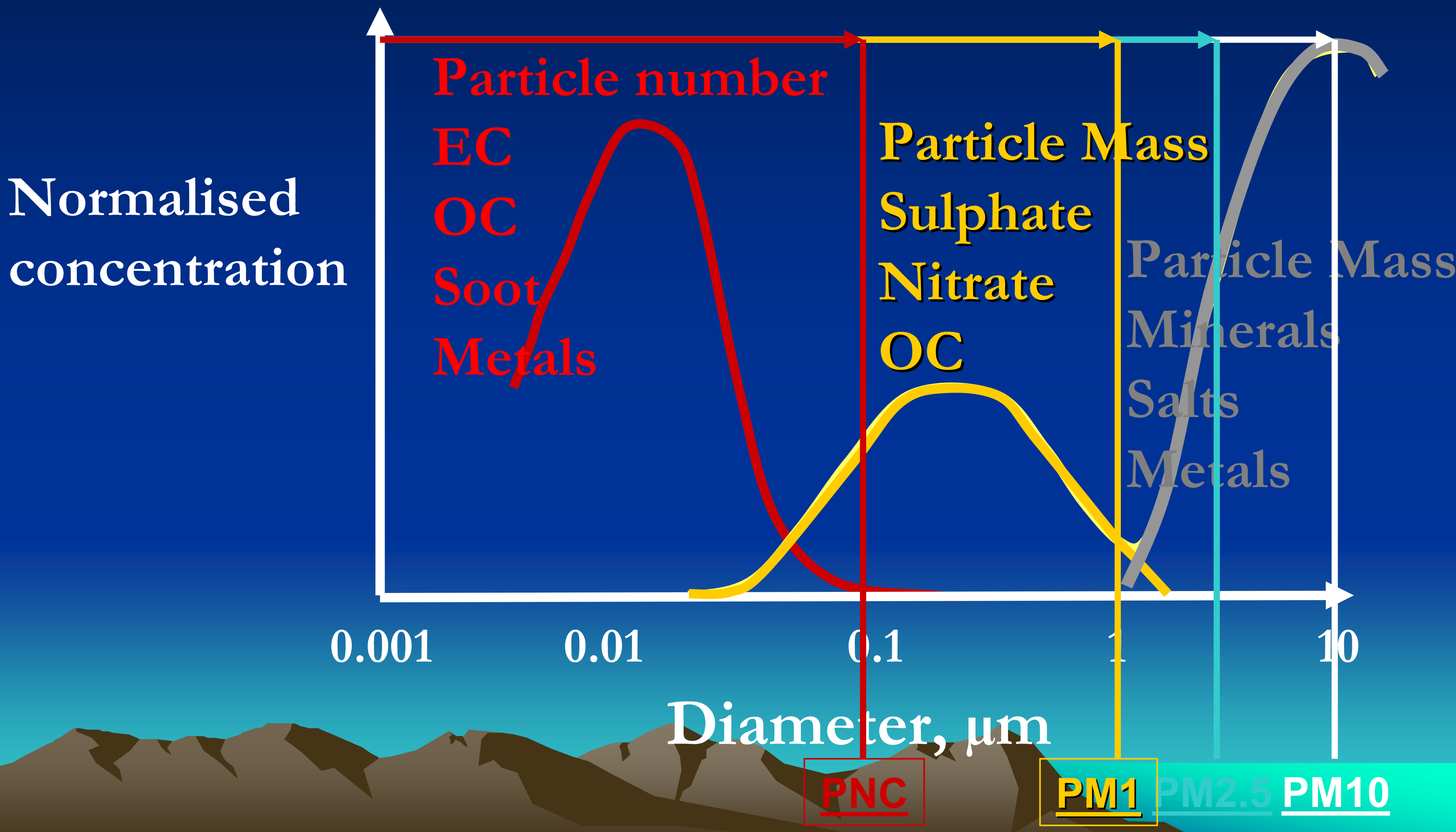
PM precursors



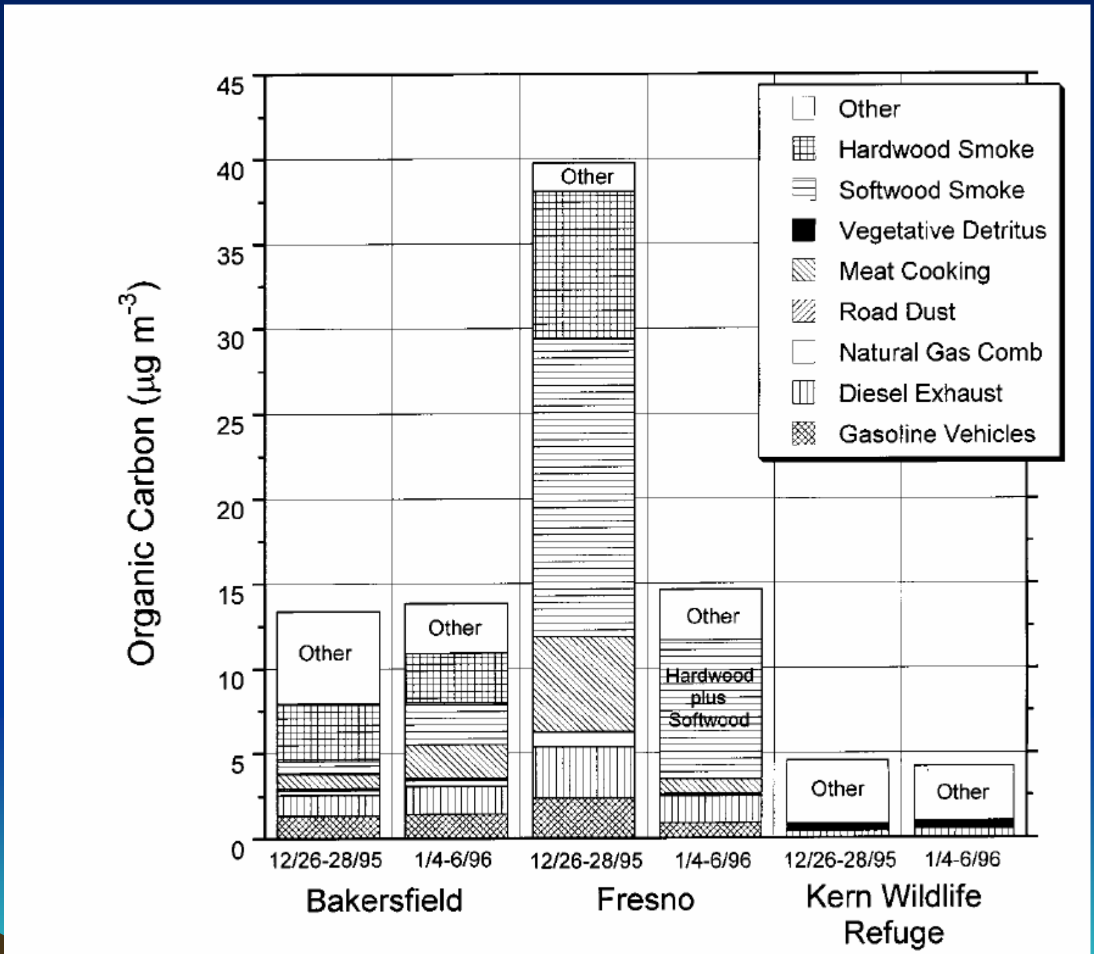
PM precursors



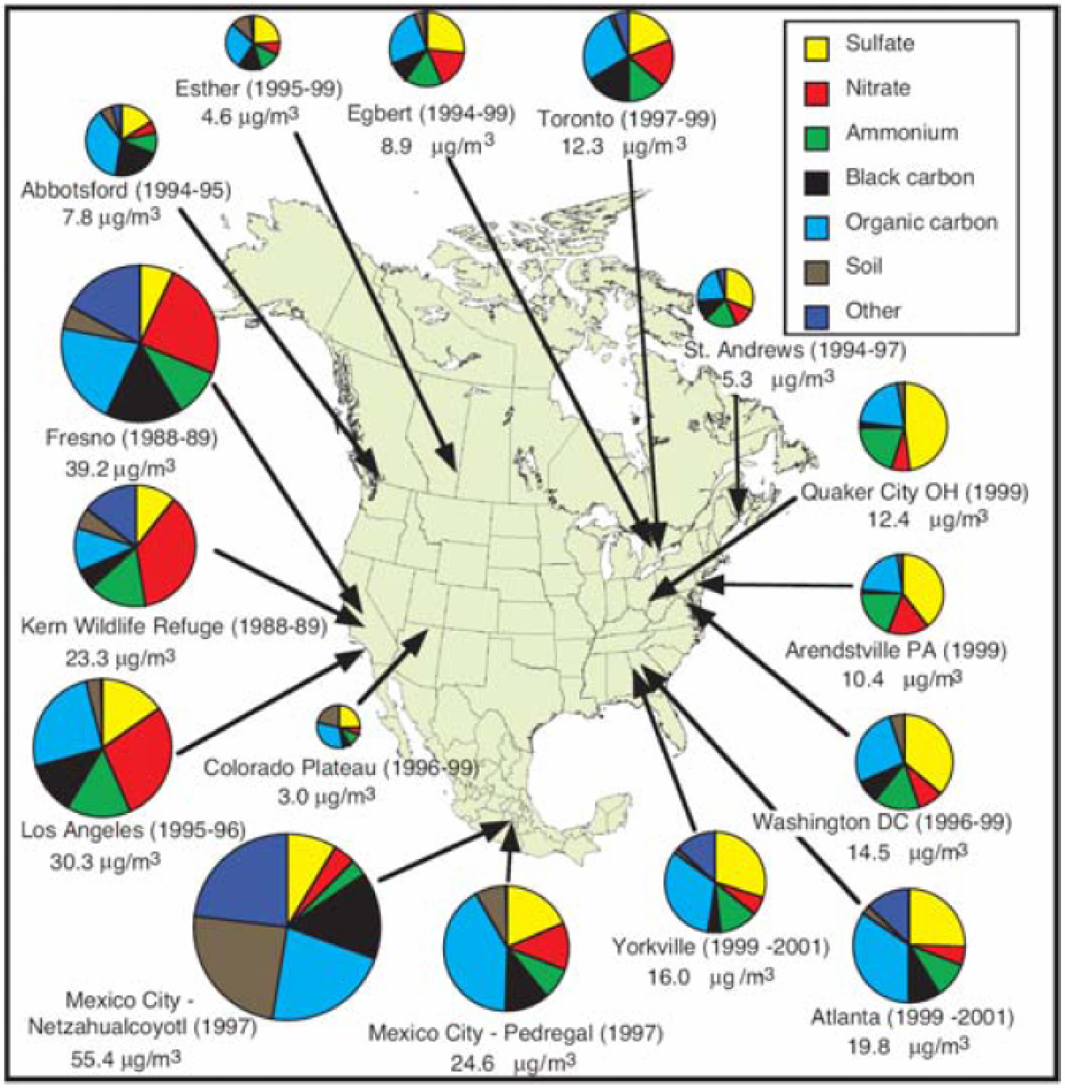
PM10 incluye muchos tipos de partículas donde el tamaño refleja su origen



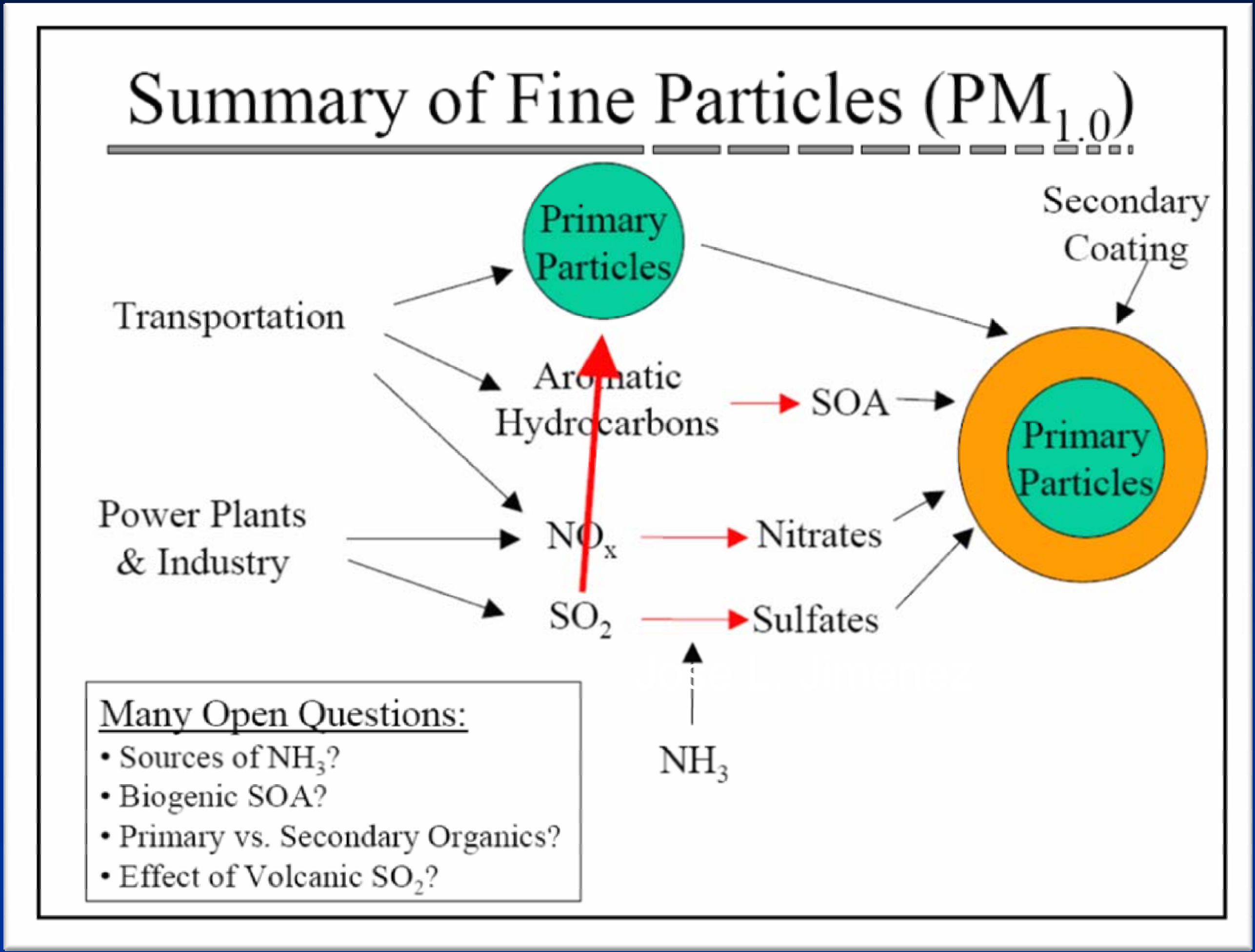
COV aportes por fuentes



$PM_{2.5}$ Across North America



NARSTO Particulate Matter Science for Policy Makers Report, 2002



Proyecto Milagro
J L Jimenez

Nomenclature

SOA(= SOAb + SOAa) secondary organic aerosols
SOAi SOA from isoprene oxidation
SOAt SOA from terpenes oxidation
SOAb(= SOAi + SOAt) SOA from biogenic VOC oxidation
SOAa SOA from aromatic (anthropogenic VOC) oxidation

K. Tsigaridis, M. Kanakidou / Atmospheric Environment 41 (2007) 4682–4692

SIMBOLOGIA

Tipo Estación

Medición permanente

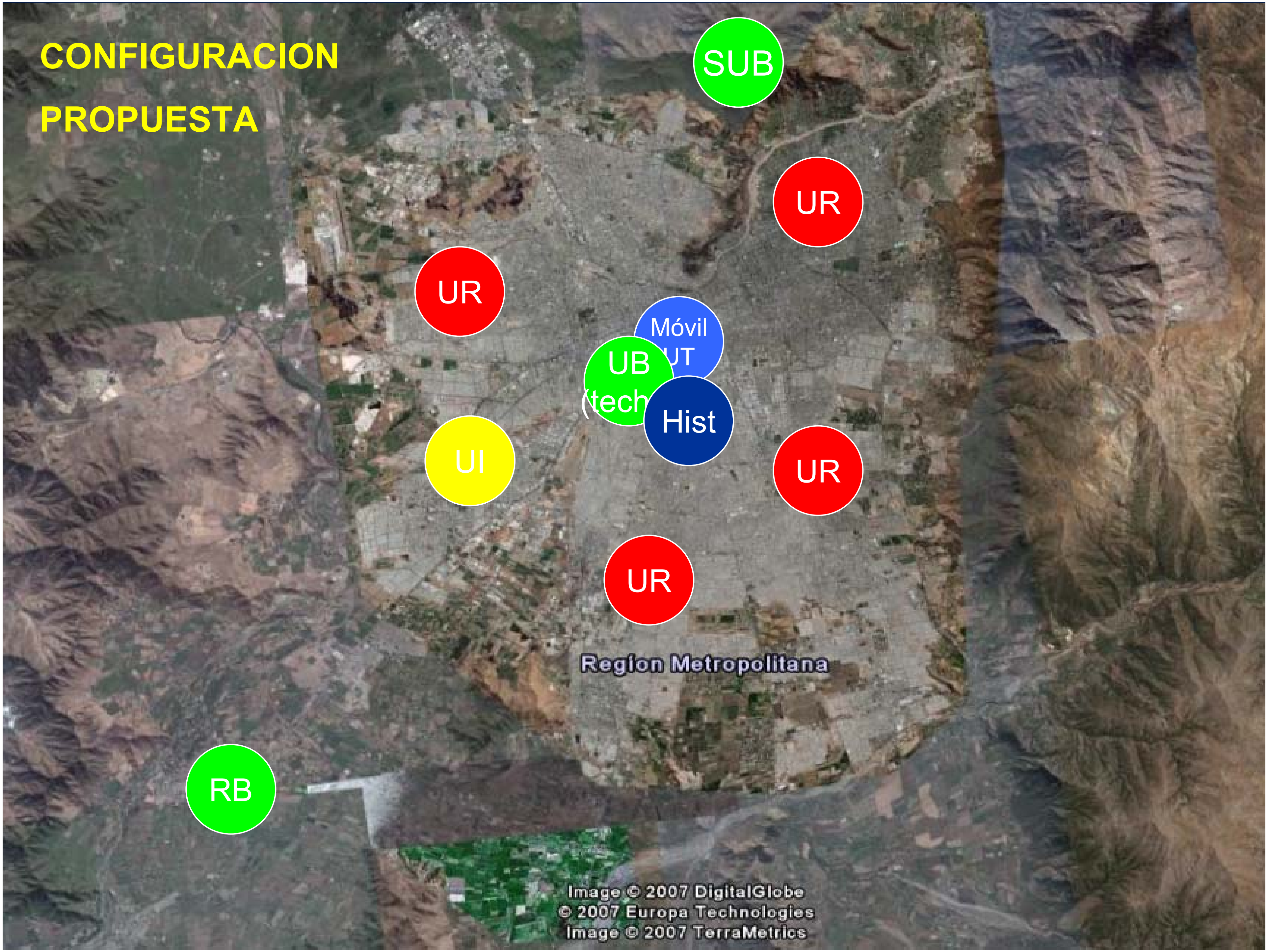
Estudios / Campañas

PM10
PM2,5
Dicotómico

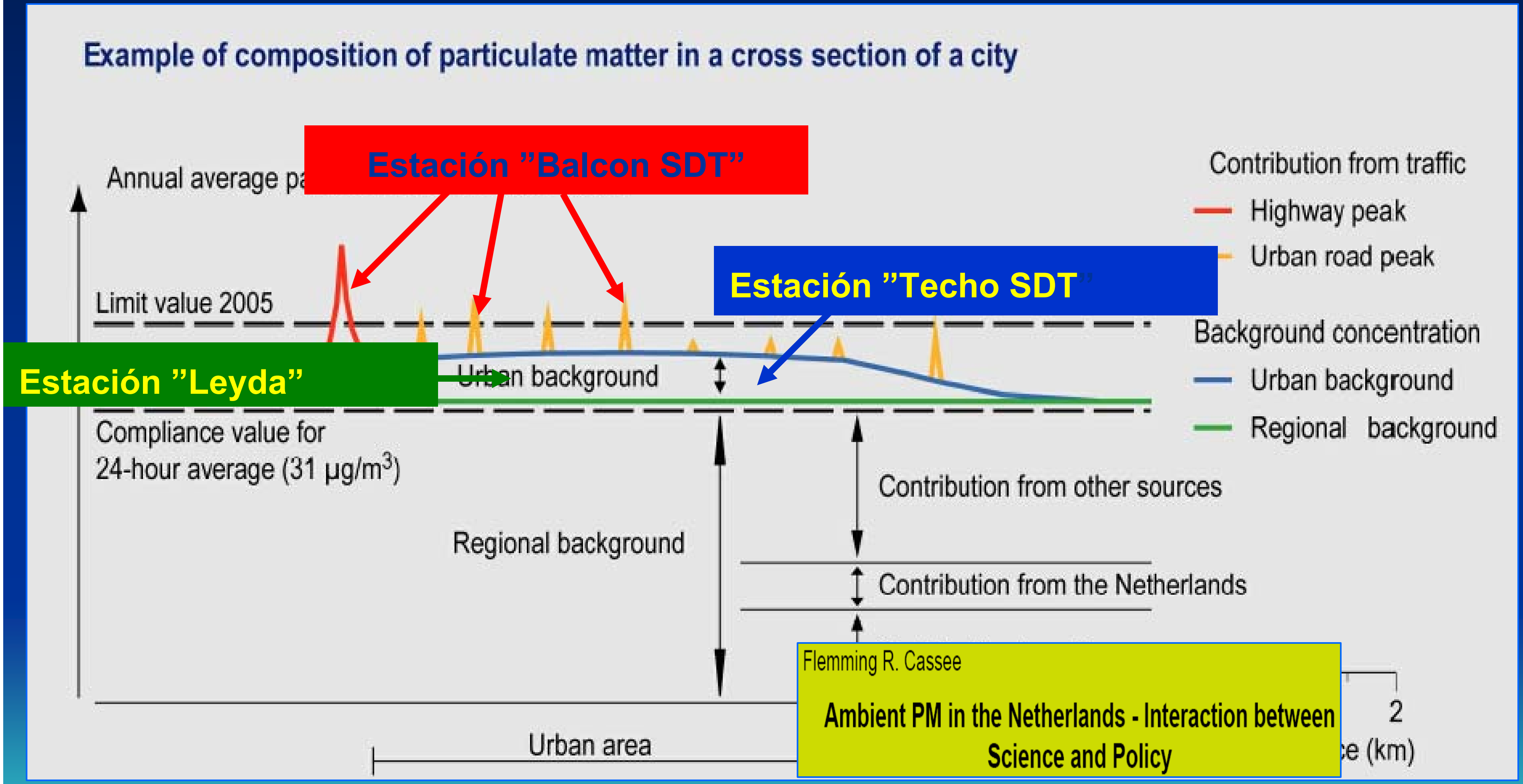
Ozono
SO2
NO/NOx

CO

Discontinuo P
Discontinuo P
COV
Tubos pasivos (BTX / NO-NO
SO2)
C Elemental
C Orgánico
APFA-CA-RM
N° PART / DI


CONFIGURACION
PROPUESTA
SUB
UR
UR
Móvil
UT
UB
(tech
Hist
UI
UR
UR
Region Metropolitana
RB
Image © 2007 DigitalGlobe
© 2007 Europa Technologies
Image © 2007 TerraMetrics

Separar las tres contribuciones background rural, background urbano y contribución local



What is needed?

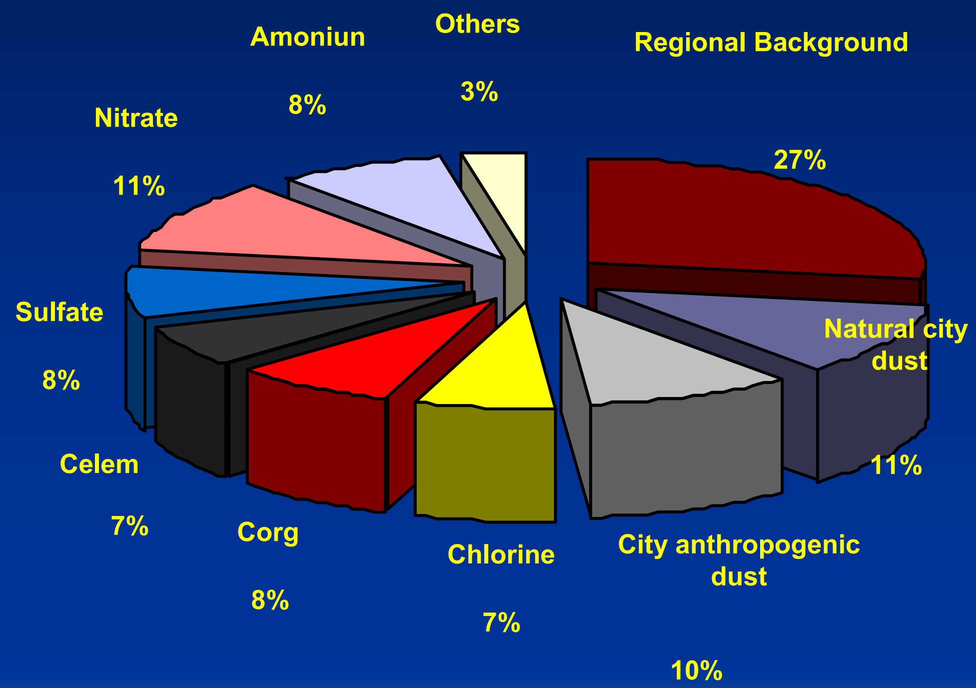
Exist relevant geographical areas at the Metropolitan Region of Santiago without AQM !!!

1. Determine the “rural background”
2. Determine the “city roof background*”
3. Determine of the contribution of other sources: diffuse, wood burning, biogenic.

   a. Use of NO-NO2, O3 and VOCs passive samplers
   b. Mobil station equipped with D truck, P truck, impactors, DMPS, CPC, for PM chemical composition and size distribution.
   c. Flexible modernization up to “Super Sites” of some of the sites with automatic, semi continuous, and passive samplers

* Necessary for modeling and health studies

"Dream Pie"



Amoniun
8%
Others
3%
Regional Background
27%
Nitrate
11%
Sulfate
8%
Natural city dust
11%
Celem
7%
Corg
8%
Chlorine
7%
City anthropogenic dust
10%

Conclusiones y Recomendaciones

- Las fuentes principales de COV y NOx siguen siendo el transporte y la industria.
- Emisiones areales de COV (estaciones bencineras y depositos de combustibles) aun sin ser evaluadas.
- A la fecha no existe un inventario satisfactorio para los COVs, desarrollado con metodologias posibles de auditar.
- Siendo el material particulado secundario organico e inorganico generado, principalmente por procesos fotoquimicos, donde los COVs y NOx son fundamentales, es mandatorio focalizar las medidas a considerar en esta etapa del PPDA, en el control de estas sustancias.
- Tanto el MPOS como MPIS debe ser medido y analizado para poder determinar la contribucion por fuentes a estos contaminates.
- Las metas del PPDA no se alcanzaran sino se considera este tema como central en la nueva etapa del PPDA.
- Se debe determinar el aporte del background rural, urbano y local de estas sustancias