Air quality in Portugal: From emissions to measures

Francisco Ferreira

FACULDADE DE CIÊNCIAS E TECNOLOGIA
UNIVERSIDADE NOVA DE LISBOA

Context

National Air Strategy for 2020

- **Gothenburg Protocol (2020)**
- **NEC (2030)**

- **Air quality levels for 2020**

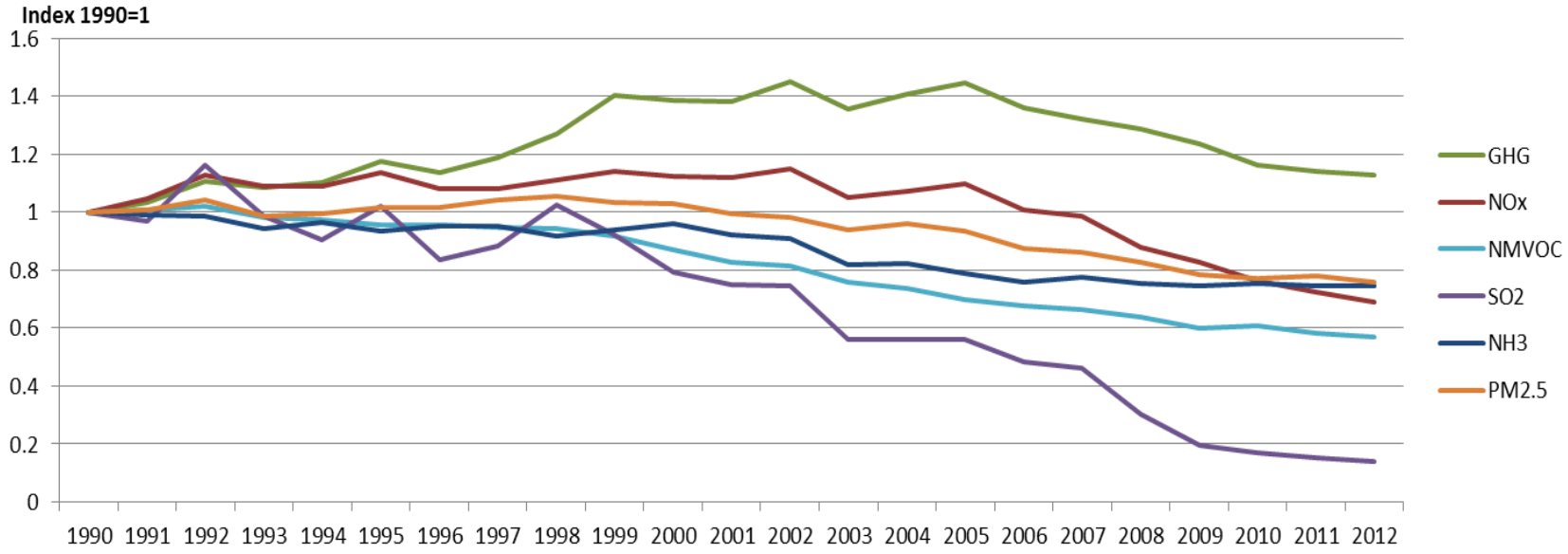
(modelling by University of Aveiro)

- **Definition of policies and measures**

Context

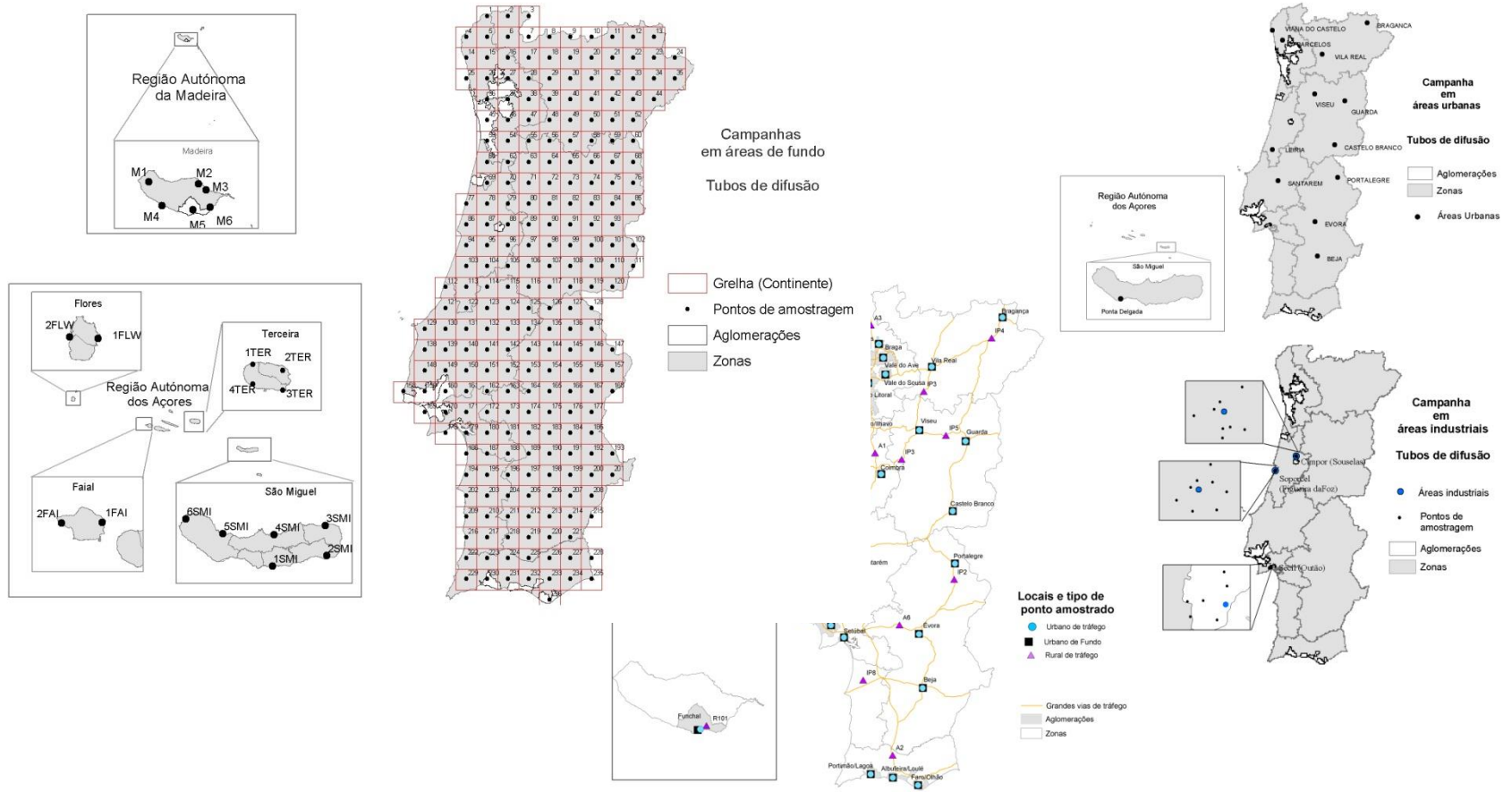
Greenhouse gases and air pollutants emissons historic evolution

Pollutant	Δ2012-1990	Δ2012-2005
GHG	13%	-32%
NOx	-31%	-41%
NMVOC	-43%	-13%
SO2	-86%	-42%
NH3	-25%	-4%
PM2.5	-24%	-18%
PM10	-16%	-29%
TSP	7%	-73%
CO	-61%	-20%

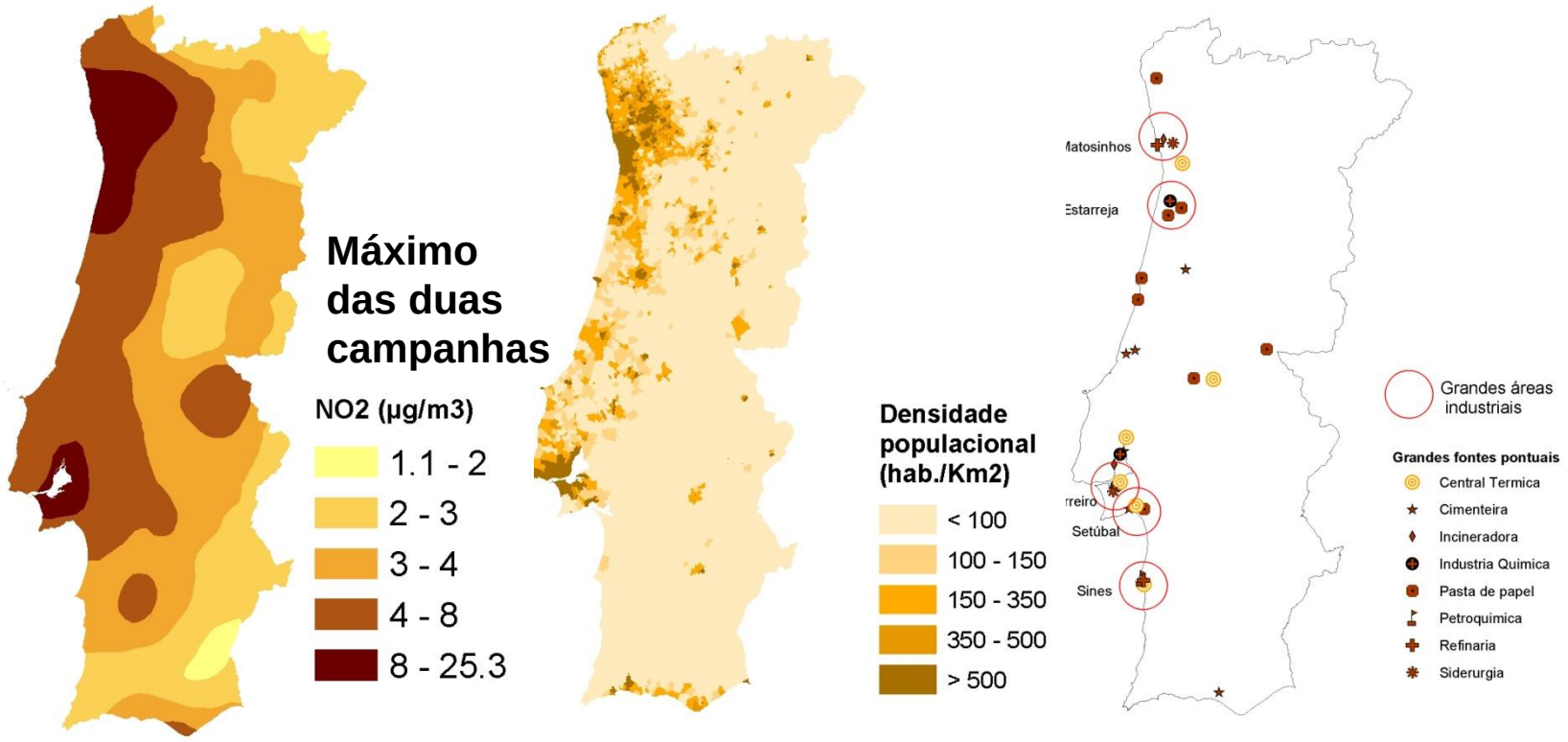


Sampling

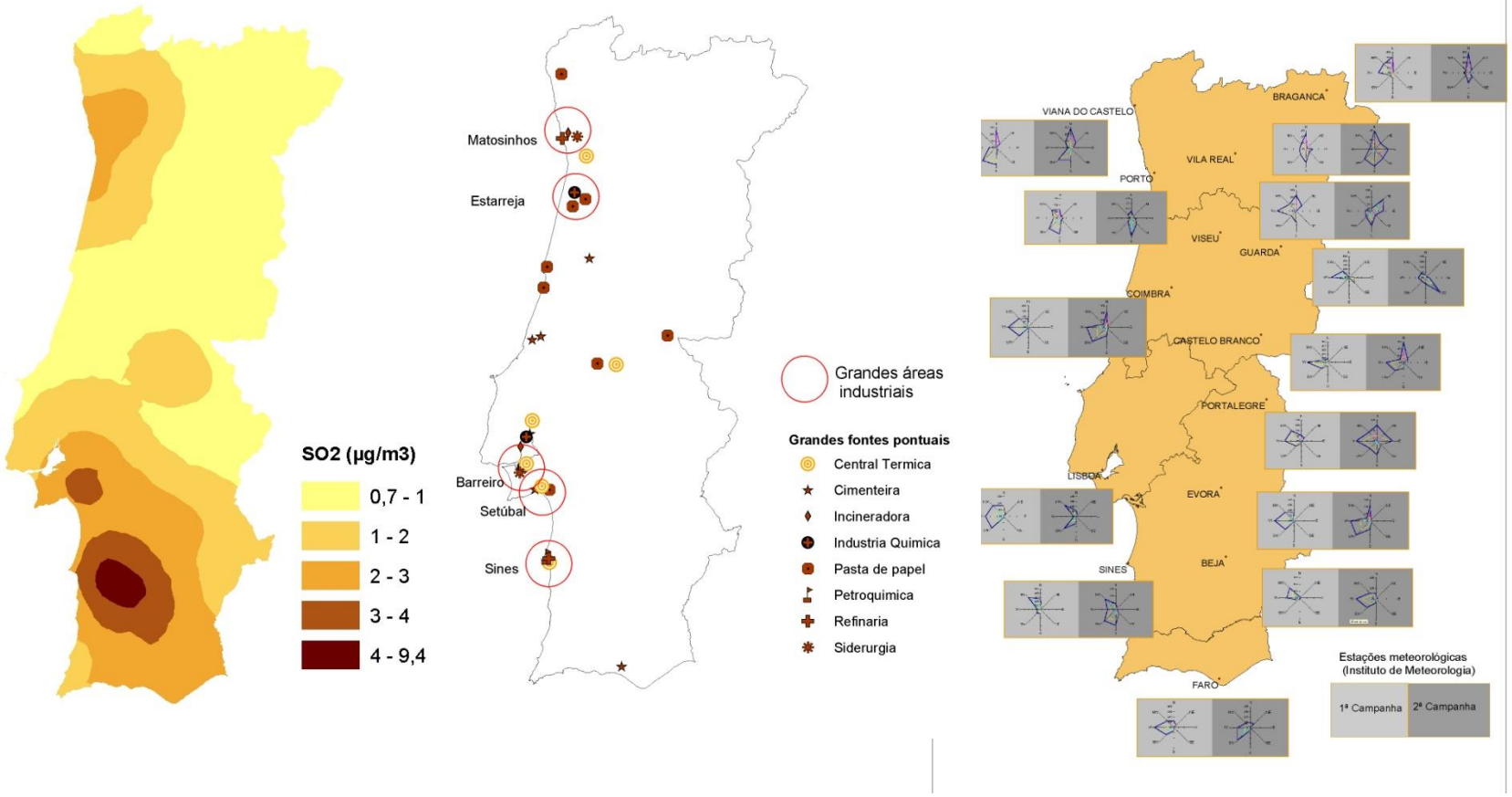
Diffusive samplers – SO_2, NO_2, C_6H_6 e O_3 + PM10 (other equipment)



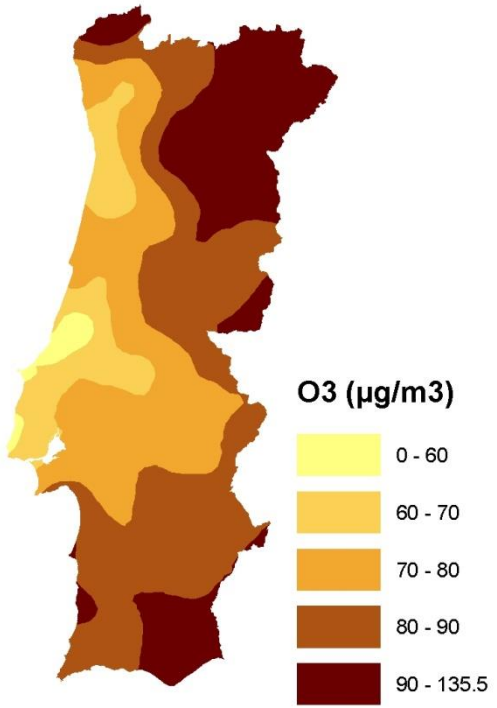
NO_2

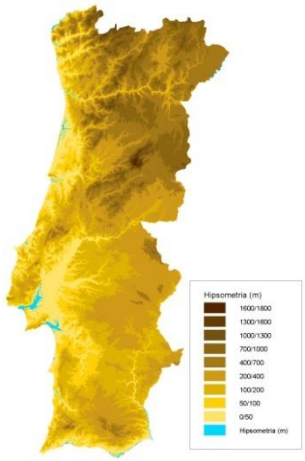

Máximo das duas campanhas
NO2 (µg/m3)
1.1 - 2
2 - 3
3 - 4
4 - 8
8 - 25.3
Densidade populacional (hab./Km2)
< 100
100 - 150
150 - 350
350 - 500
> 500
Matosinhos
Estarreja
Setúbal
Sines
Grandes áreas industriais
Grandes fontes pontuais
Central Termica
Cimenteira
Incineradora
Industria Quimica
Pasta de papel
Petroquimica
Refinaria
Siderurgia

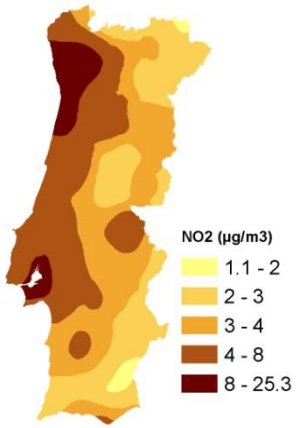
SO_2

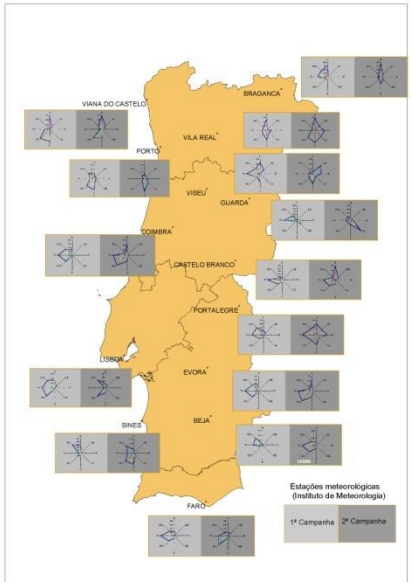

SO2 (µg/m3)
0,7 - 1
1 - 2
2 - 3
3 - 4
4 - 9,4
Matosinhos
Estarreja
Barreiro
Setúbal
Sines
Grandes áreas industriais
Grandes fontes pontuais
Central Termica
Cimenteira
Incineradora
Industria Quimica
Pasta de papel
Petroquimica
Refinaria
Siderurgia
VIANA DO CASTELO
BRAGANCA
VILA REAL
PORTO
VISEU
GUARDA
COIMBRA
CASTELO BRANCO
PORTALEGRE
LISBOA
EVORA
BEJA
SINES
FARO
Estações meteorológicas (Instituto de Meteorologia)
1ª Campanha
2ª Campanha

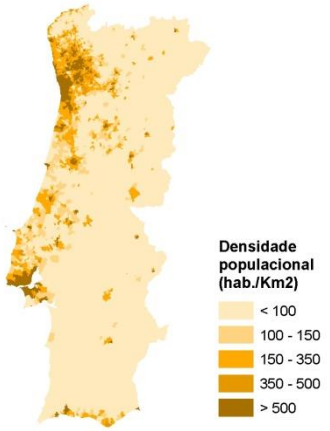
O_3


O3 (µg/m3)
0 - 60
60 - 70
70 - 80
80 - 90
90 - 135.5


Hipsometria (m)
1600/1800
1300/1600
1000/1300
700/1000
400/700
200/400
100/200
50/100
0/50
Hipsometria (m)

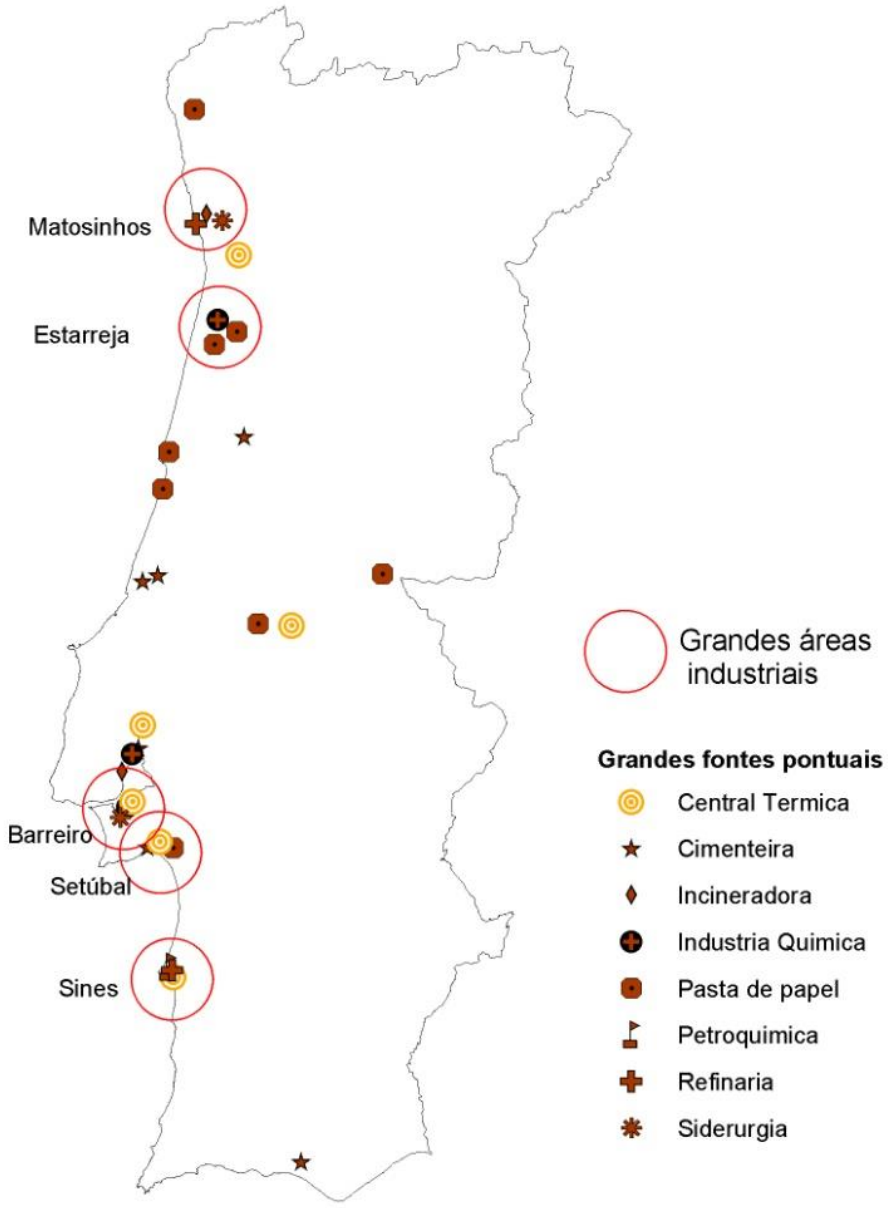

NO2 (µg/m3)
1.1 - 2
2 - 3
3 - 4
4 - 8
8 - 25.3


VIANA DO CASTELO
BRAGANCA
VILA REAL
PORTO
VISEU
GUARDA
COIMBRA
CASTELO BRANCO
PORTALEGRE
LISBOA
EVORA
BEJA
SINES
FARO
Estações meteorológicas
(Instituto de Meteorologia)
1ª Campanha
2ª Campanha


Densidade
populacional
(hab./Km2)
< 100
100 - 150
150 - 350
350 - 500
> 500

Point sources

- Power Plants (2 coal)
- Siderurgy
- Refineries
- Pulp and paper
- Chemical
- Cement



Example: Sines Power Plant

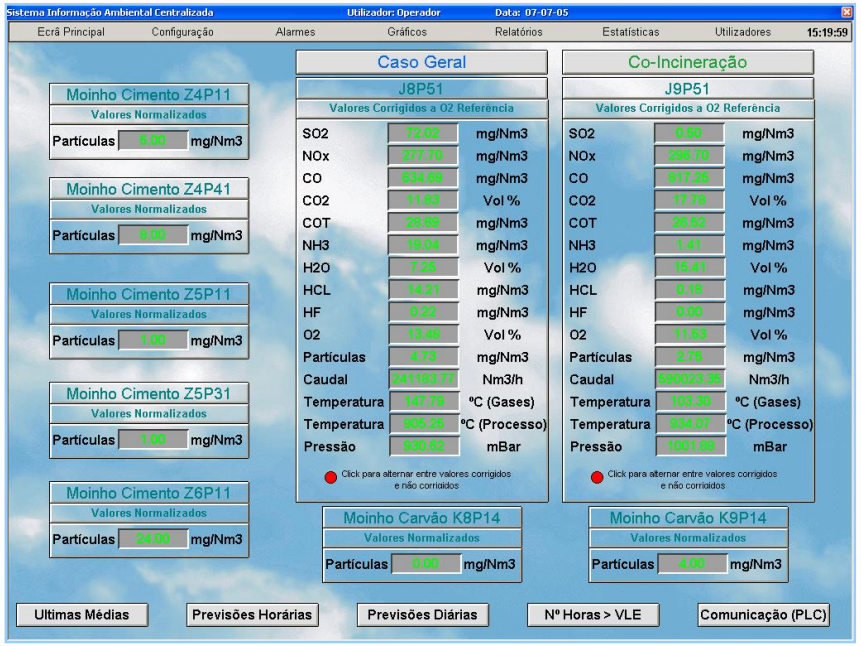
Flue-gas desulphurization

Denitrification

Electrostatic precipitators

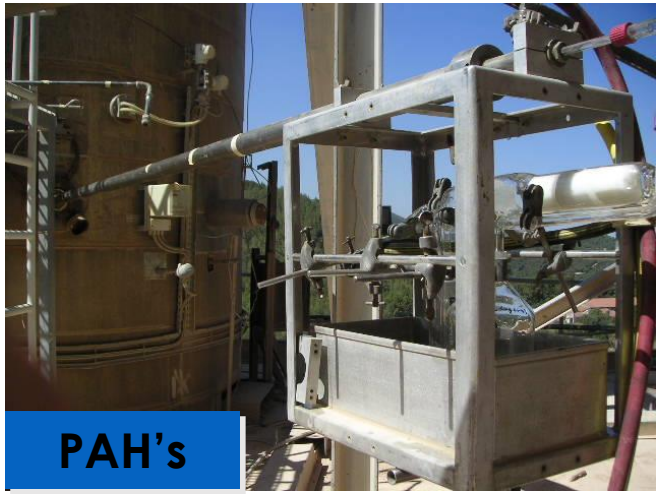
Real-time emissions measurements

- Example: Particles, CO, NOX, TOC, HCl, HF



Hazardous waste incineration

- Sampling equipment



Sahara/Sahel and forest fires (natural events)

- **Station monitoring data**

- Modelling
- Satellite imagery

Natural events identification

Tools:

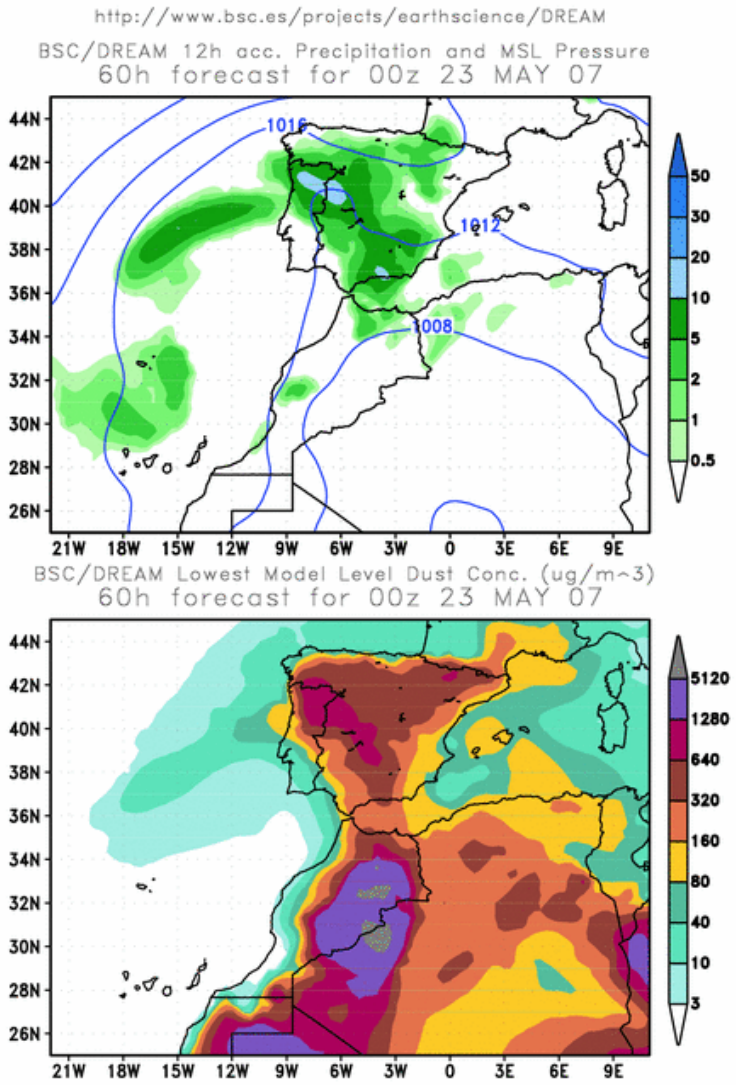
1. **BSC-DREAM**
2. **SKIRON**
3. **NAAPs-NRL**
4. **Air masses retrotrajectories (HYSPLIT) Navy-USA NRL**
5. **SeaWIFS, MODIS-Terra satellite imagery**
6. **TOMS**

Identification fo natural events

Northern African events

- **Model BSC-Dream**
  (Barcelona Supercomputer Centre)

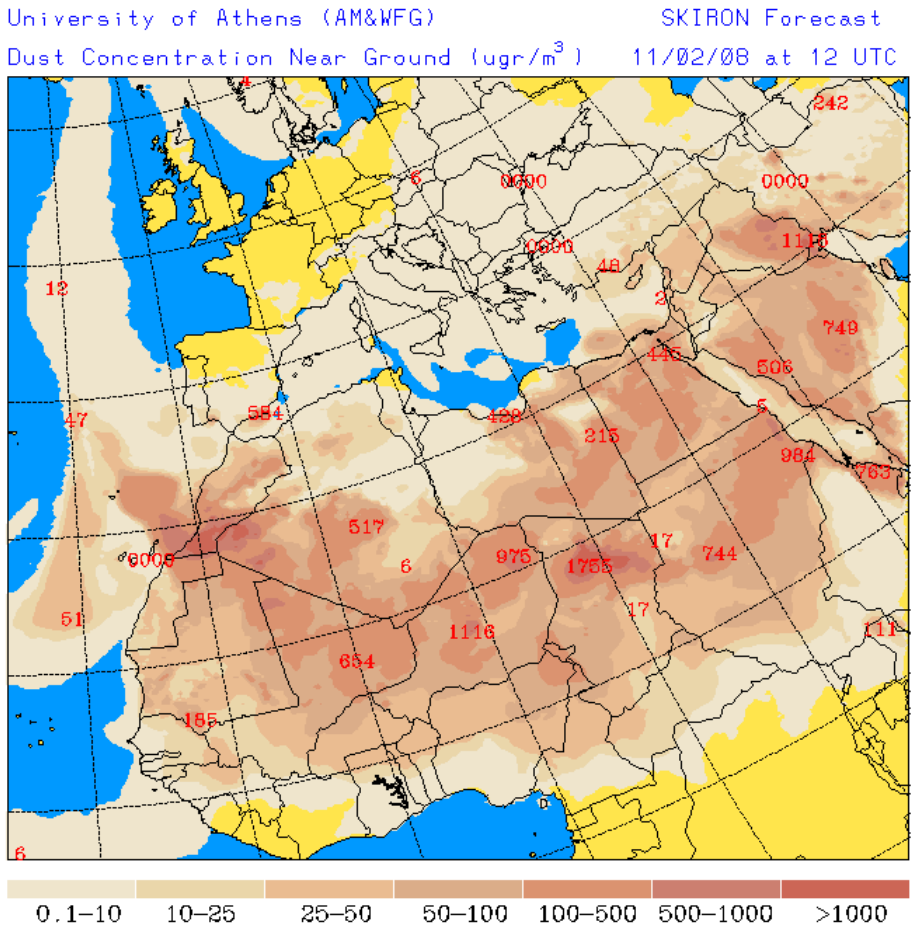
- Based on satellite imagery
- Cloud cover
- Aerosols
- Surface concentration
- Forecasting



Identification fo natural events

Northern African events

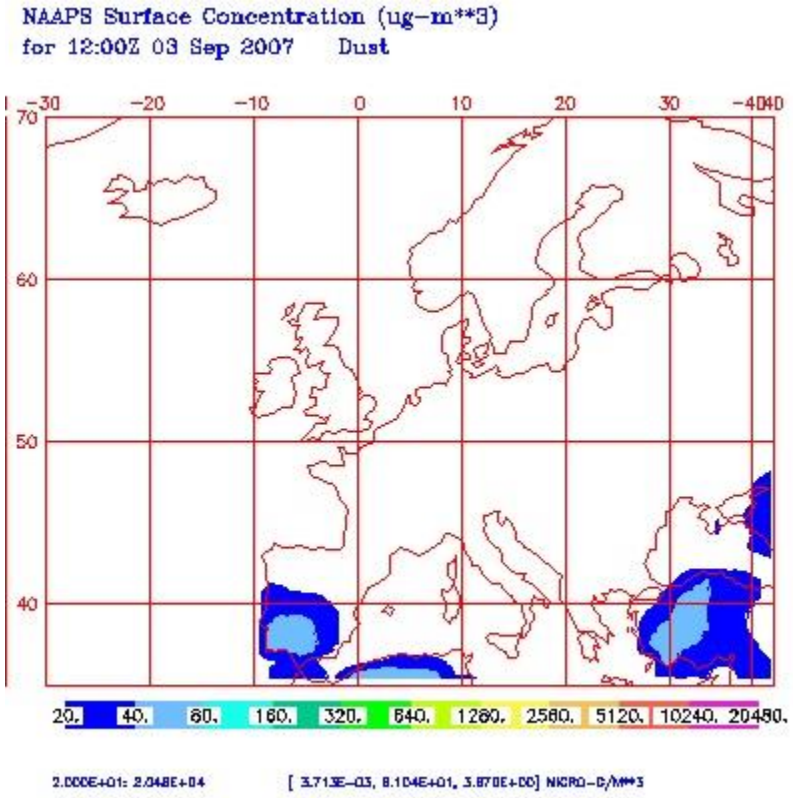
- **Modelo SKIRON (Univ. Atenas)**



Identification fo natural events

Northern African events

- **Modelo NAAPS**
- **(Navy Aerosol Analysis and Prediction System)**
- **Naaps Global Aerosol Model**

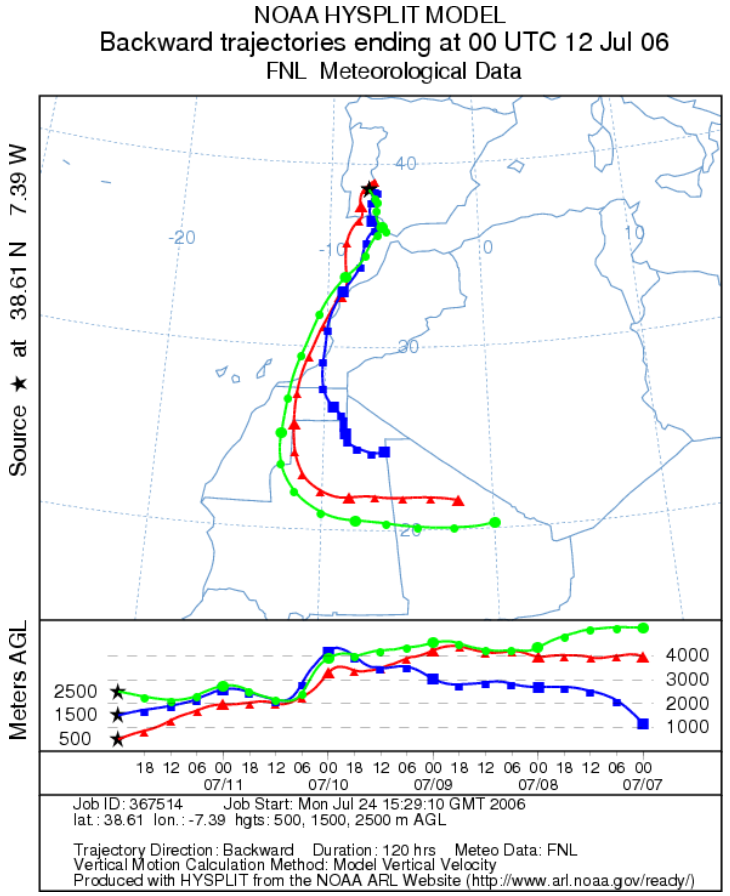


Naval Research Laboratory, Monterey USA
http://www.nrlmry.navy.mil/aerosol/#currentaerosolmodeling

Identification fo natural events

Northern African events

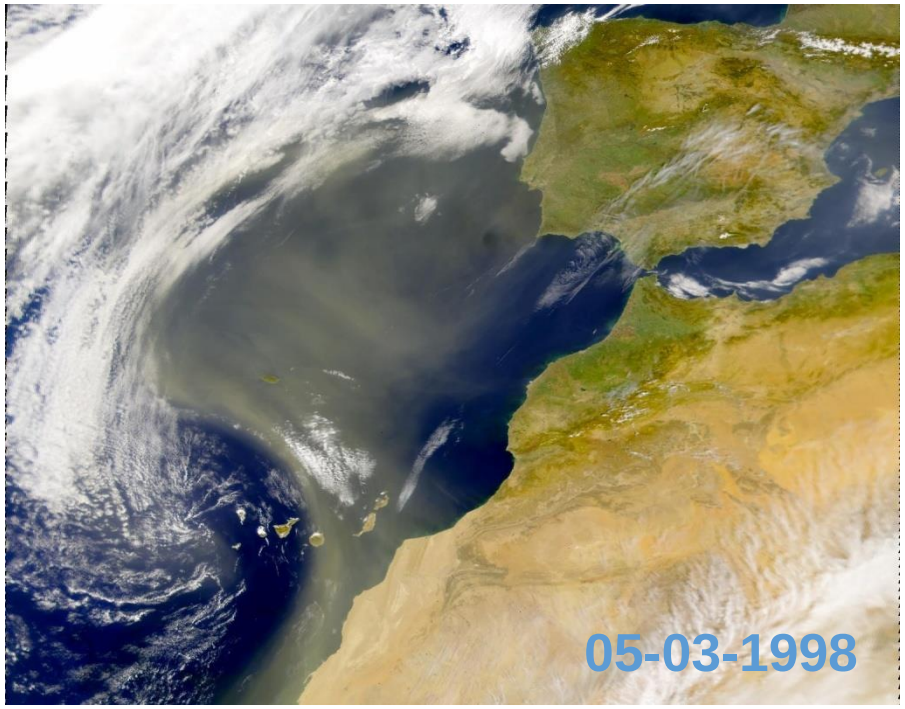
- **Modelo Hysplit**
- **(NOAA/Dep. Commerce - USA)**



MODELO ftp://www.arl.noaa.gov/pub/models
METEO FILES ftp://www.arl.noaa.gov/pub/archives/fnl

Identification fo natural events

Northern African events



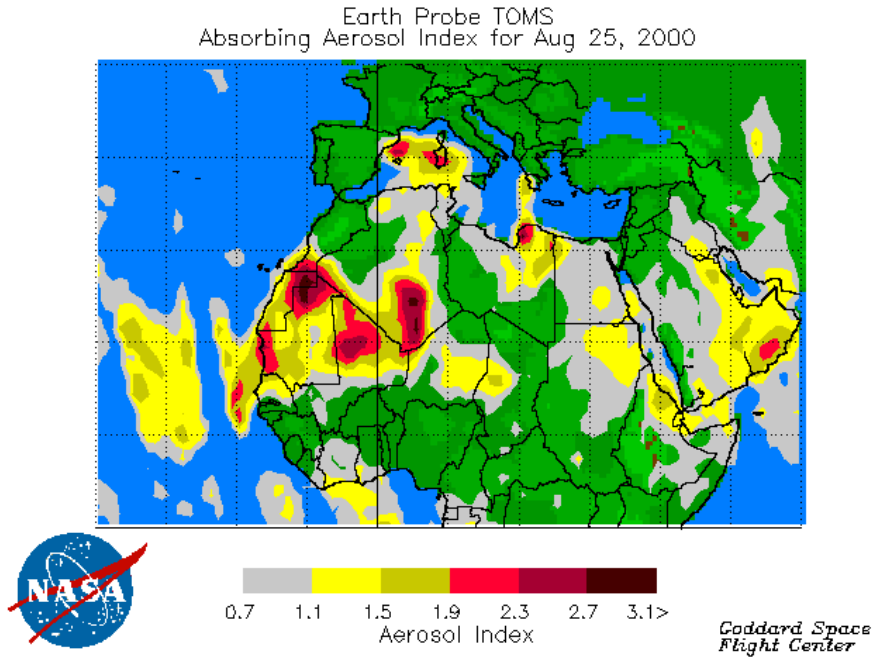
- **Satélite SeaWIFS (NASA)**
- SeaWIFS: for chlorophyll
- Not éideal but good photos ☺ (ex.: 05/Mar/1998)

http://seawifs.gsfc.nasa.gov/cgibrs/hrpt_browse.pl

Identification fo natural events

Northern African events

- **Satélite TOMS (NASA)**



- Aerosols index
- Outdated

EUROPA
ftp://jwocky.gsfc.nasa.gov/pub/tmp/meduse

ESCALA GLOBAL
http://jwocky.gsfc.nasa.gov/

Identification fo natural events

Chemical mass balance

		PM_{10}
crustal	**%**	**51.5**
CO_3^{2-}	$\mu g.m^{-3}$	9.12
SiO_2	$\mu g.m^{-3}$	6.97
Al_2O_3	$\mu g.m^{-3}$	2.58
P_2O_5	$\mu g.m^{-3}$	0.89
Ca	$\mu g.m^{-3}$	6.08
Fe	$\mu g.m^{-3}$	1.47
K	$\mu g.m^{-3}$	1.43
Mg	$\mu g.m^{-3}$	0.45

CRUSTAL

CO_3^{2-}, SiO_2, Al_2O_3, P_2O_5,, Ca, Fe, K, Mg

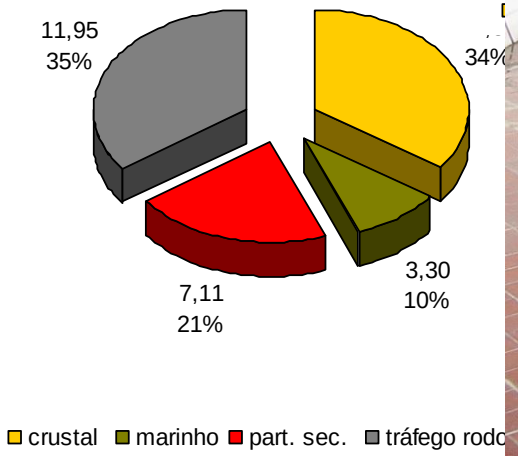
2.5* Al_2O_3 = SiO_2

GRAVIMETRY	**PM_{10}**	**61.3 $\mu g.m^{-3}$**

Identification fo natural events

Chemical mass balance

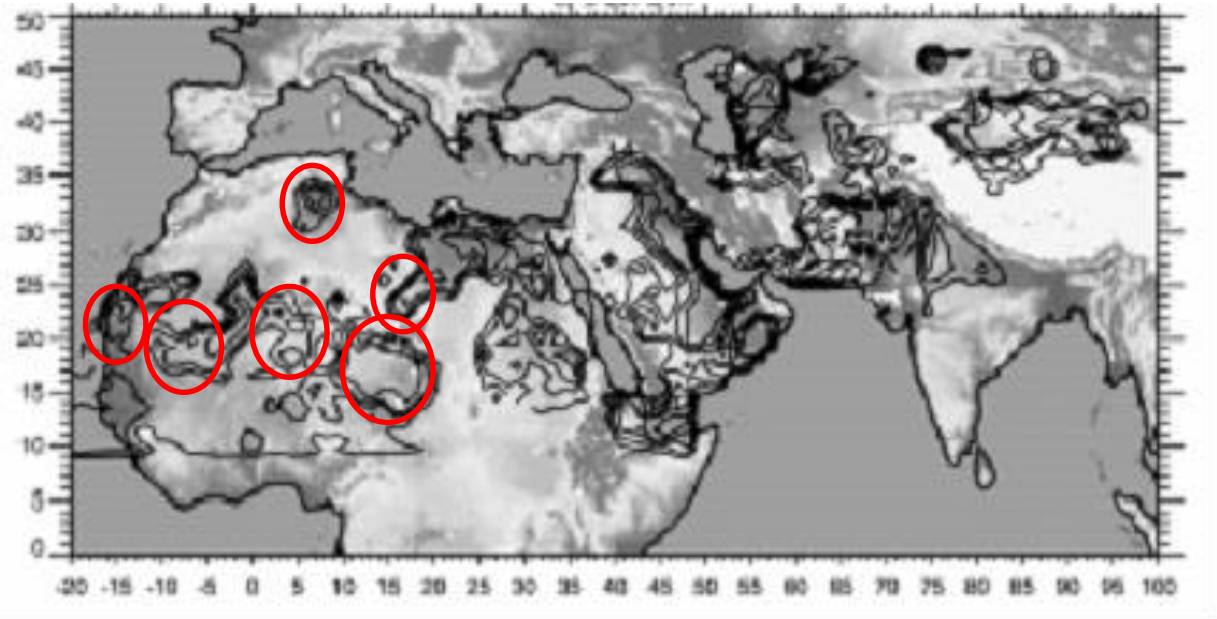
>Rodov



DCEA-FCT/UNL, CCDRLVT, 2006

Long distance transport

Origin of episodes



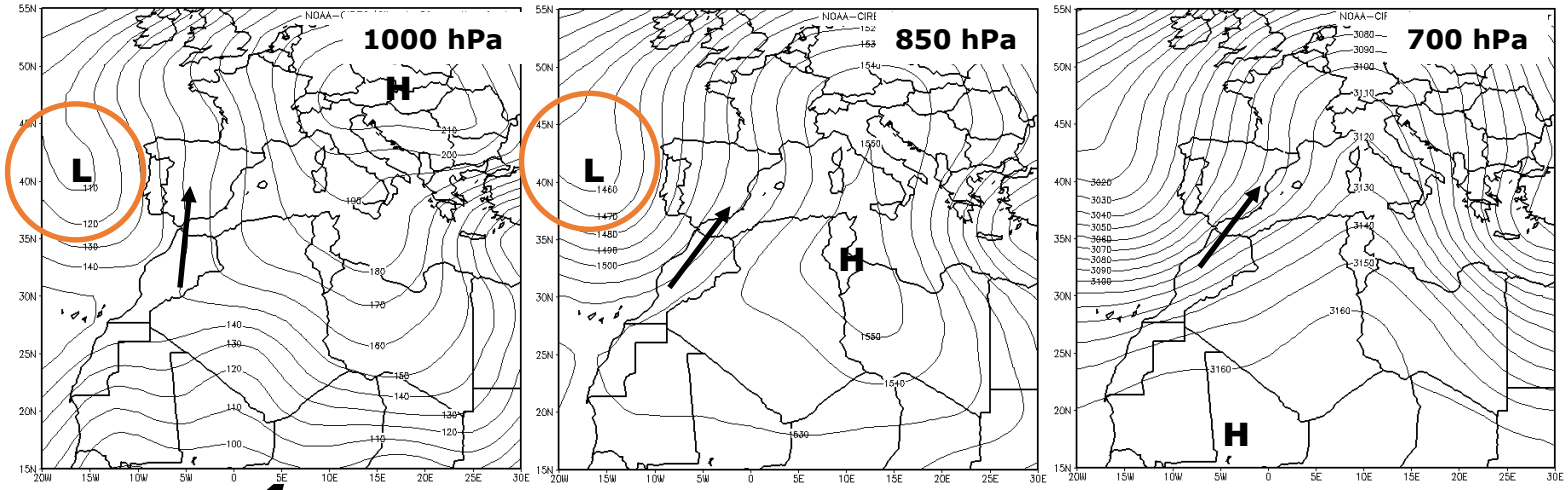
Natural events

Metereology and probability of occurence

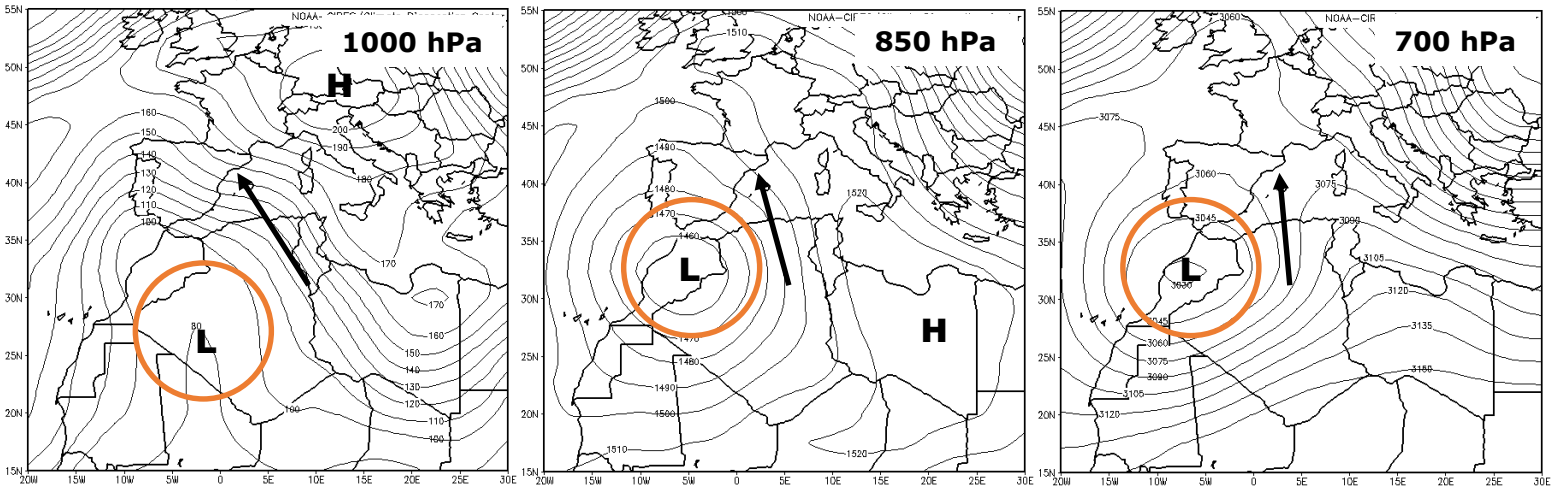
Tipo de evento	Período	Fonte e meteorologia
Fraca probabilidade, apenas áreas Sul	Novembro - Janeiro	Injecção atmosférica de poeiras inibida, eventos de poeiras apenas nas áreas Sul (P. Ibérica)
Eventos secos	Fevereiro - Março	Sahel Nuvens de partículas do Atlântico Anticiclones (Med+NAF)
Chuvas vermelhas & Eventos secos	Abril - Junho	Sahel a Sahara Depressões (SW Portugal) e/ou Anticiclone (Med+NAF)
Eventos secos	Julho - Agosto	Sahara Vastos e intensos *outbreaks* de poeiras; anticyclone (Med+NAF)
Chuvas vermelhas & Eventos secos	Setembro - Outubro	Sahara a Sahel Depressões (SW Portugal) e/ou Anticiclone (Med+NAF)

Transporte a longa distância de partículas: características meteorológicas

Atlantic Depression:



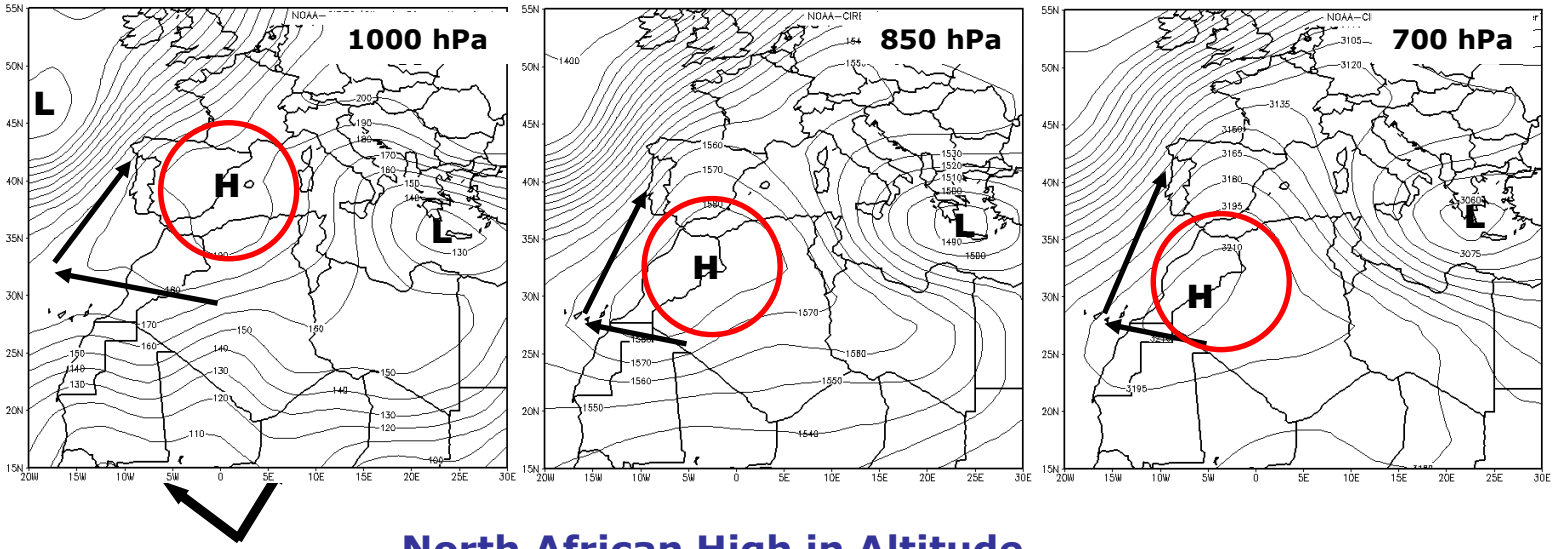
North African Depression:



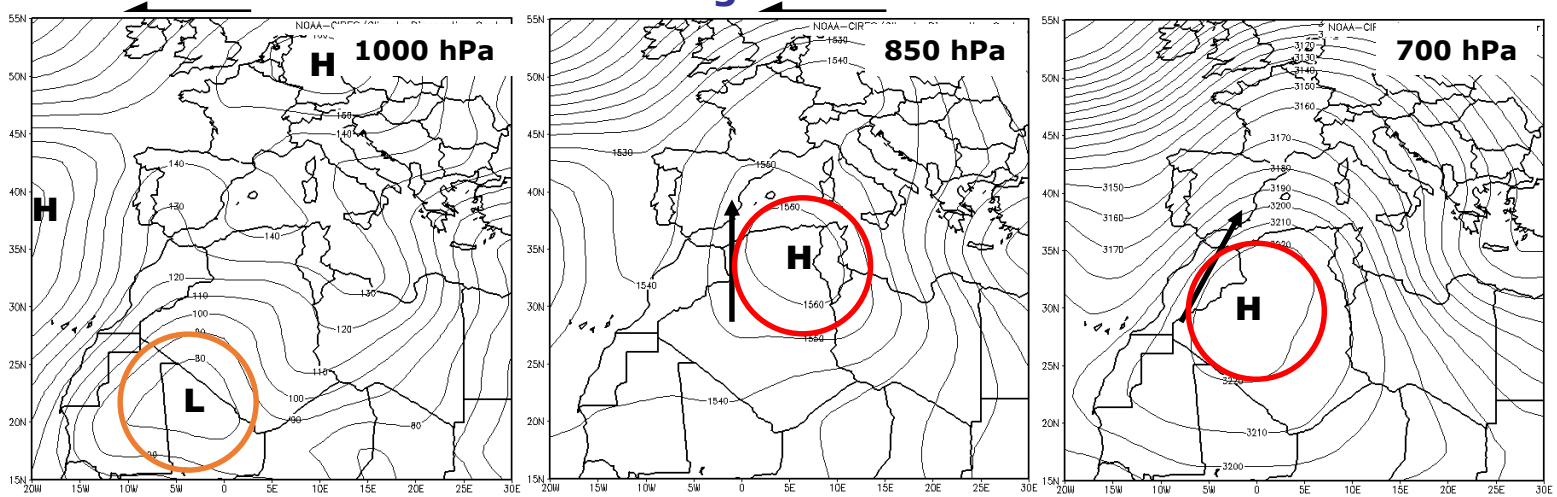
Diapositivo desenhado por Querol, IJA

Transporte a longa distância de partículas: características meteorológicas

North African High in Surface



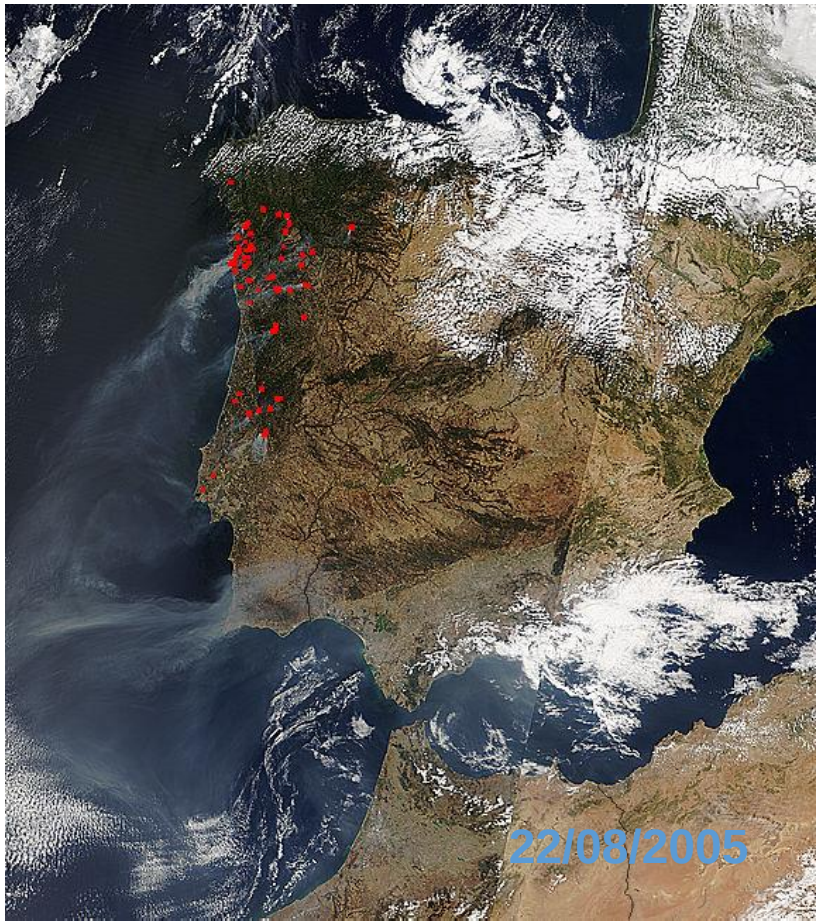
North African High in Altitude



Diapositivo desenhado por Querol, IJA

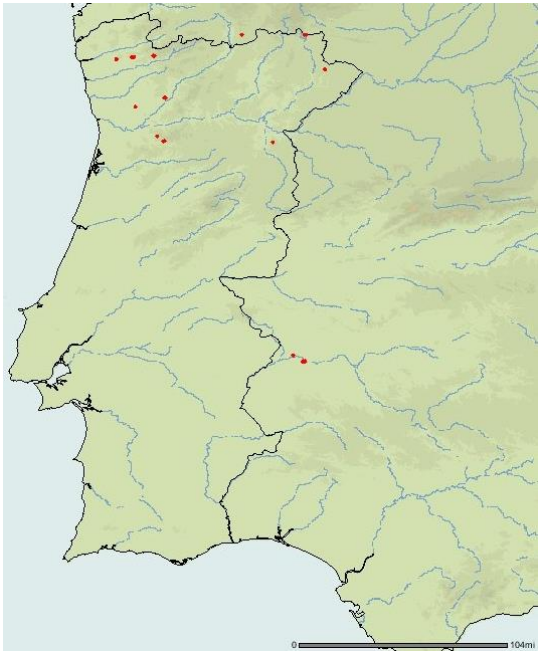
Forest fires

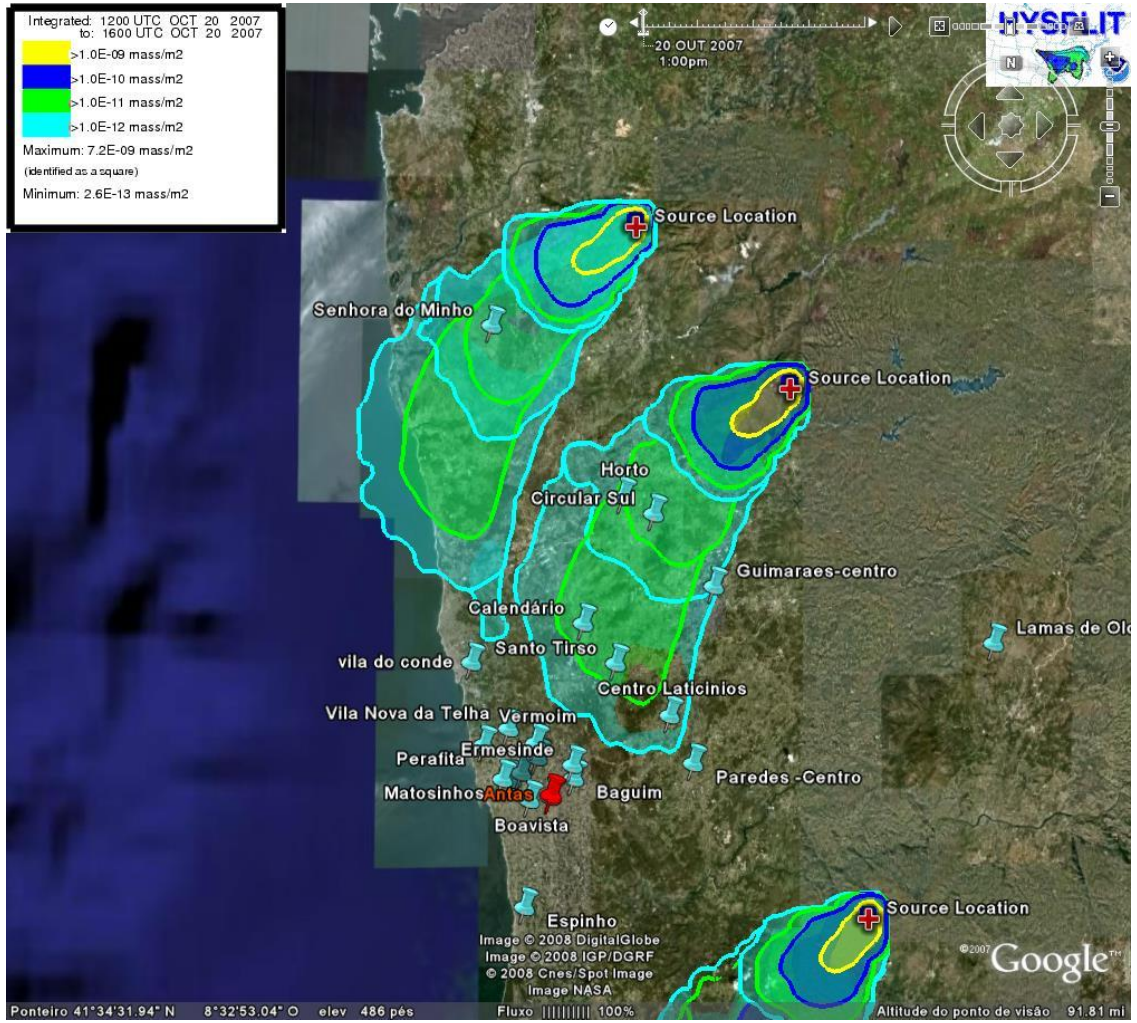
- **Satellite (ex: Modis Terra e Aqua), Databases (ex: DGRF)**



Forest fires

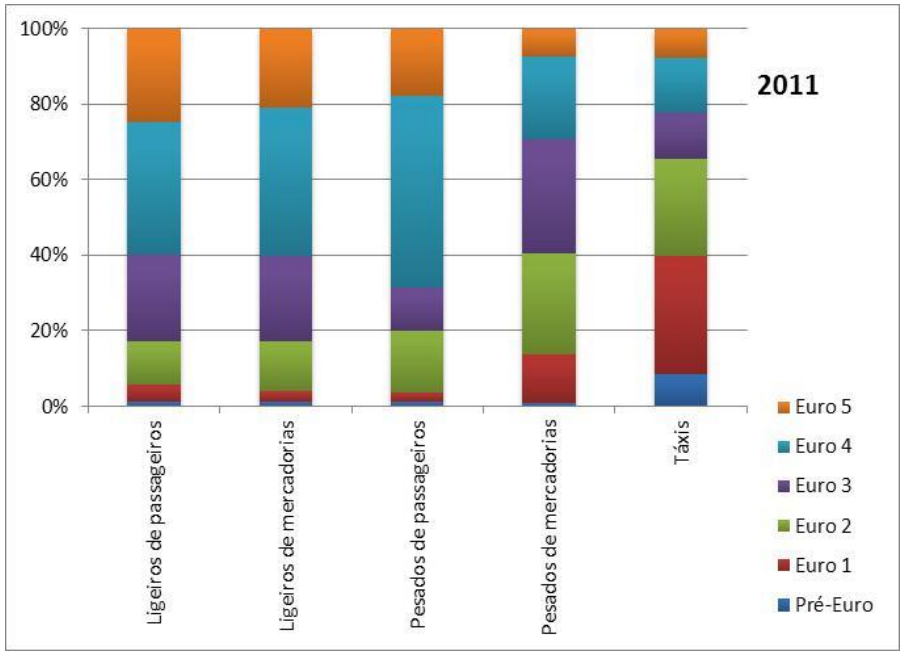
- **Combination of satellite imagery* + Model (Hysplit)**
- ***web fire mapper**

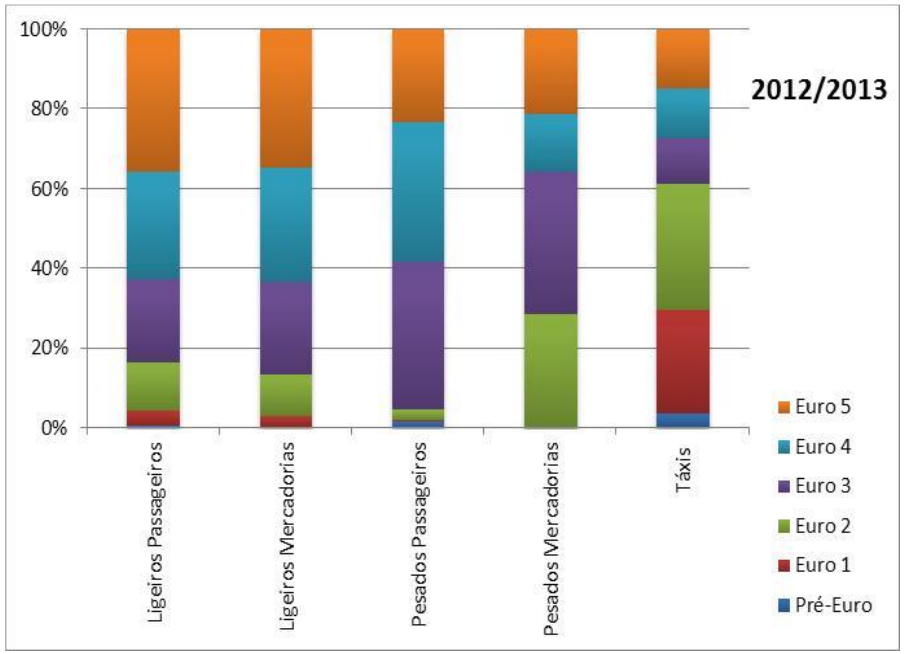


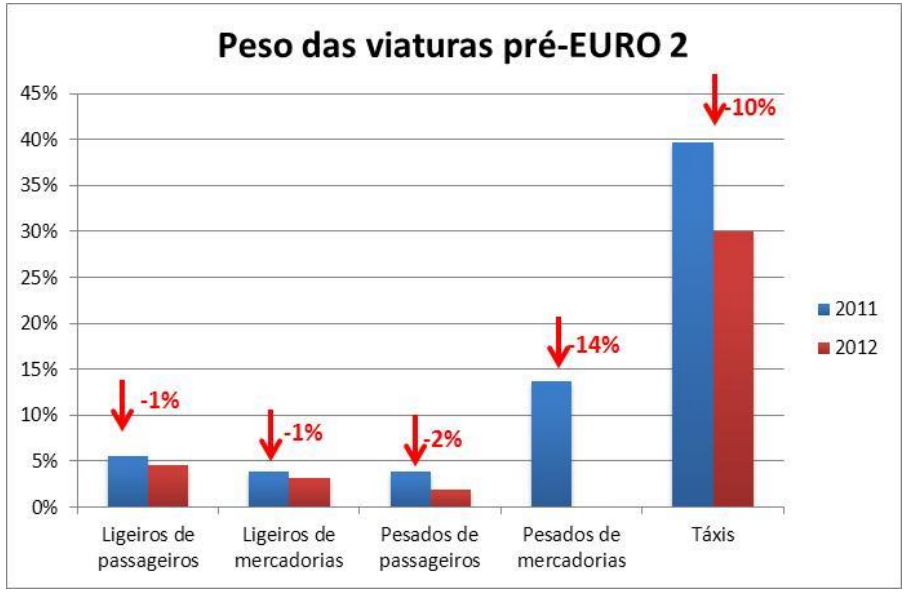


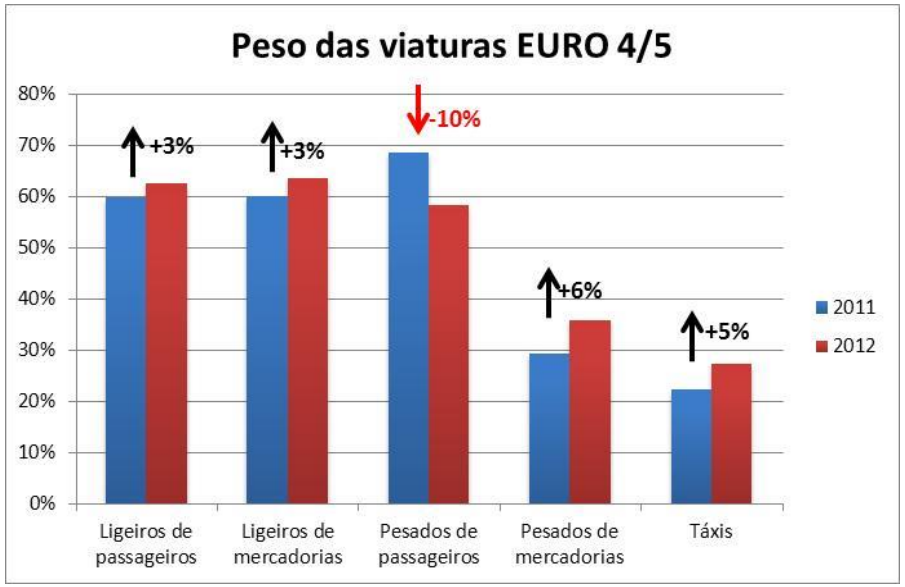
Plans and Programmes to Improve Air quality

Before and after ZER Phase II – Fleet characterization



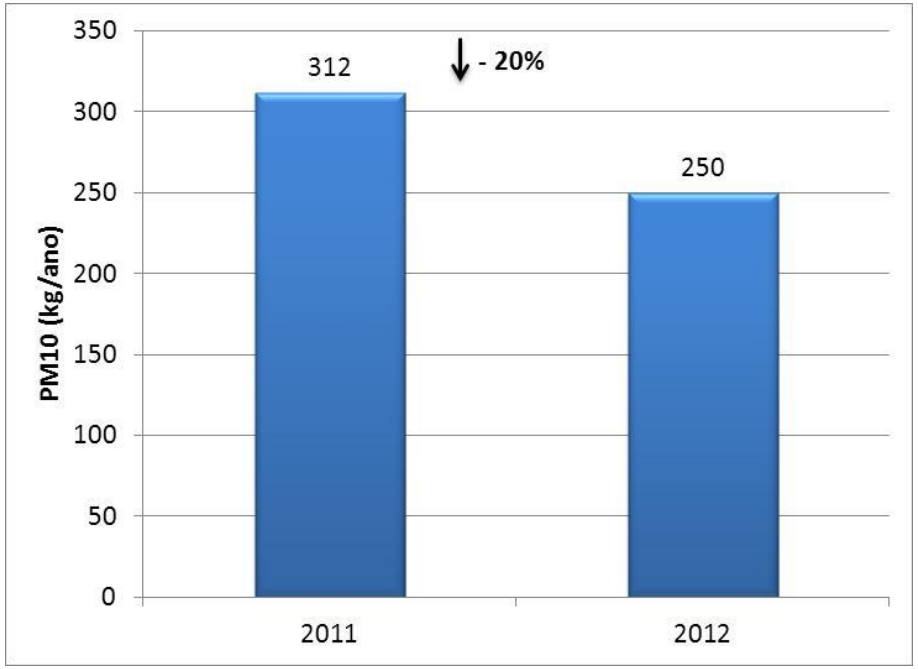


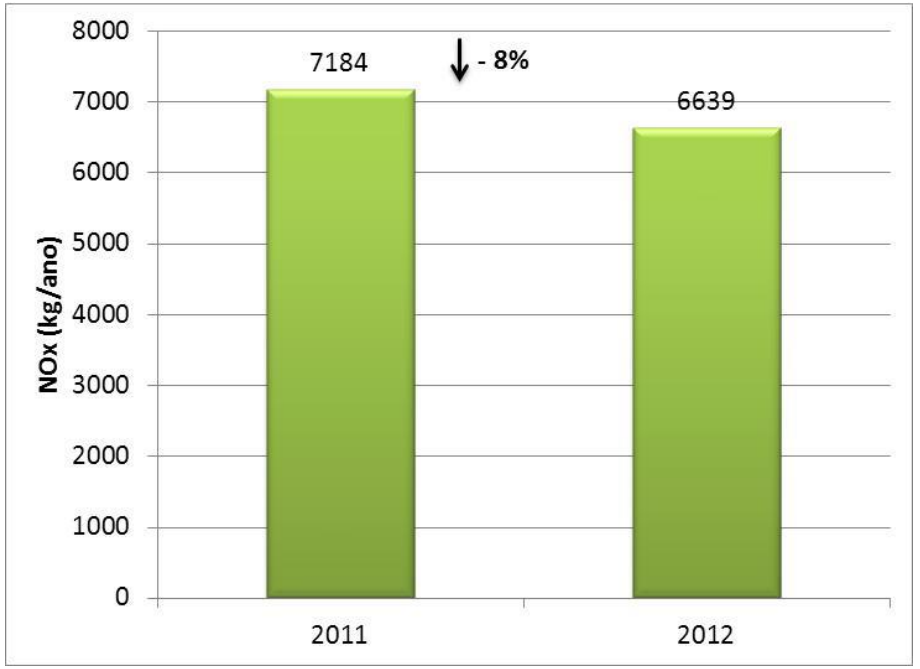




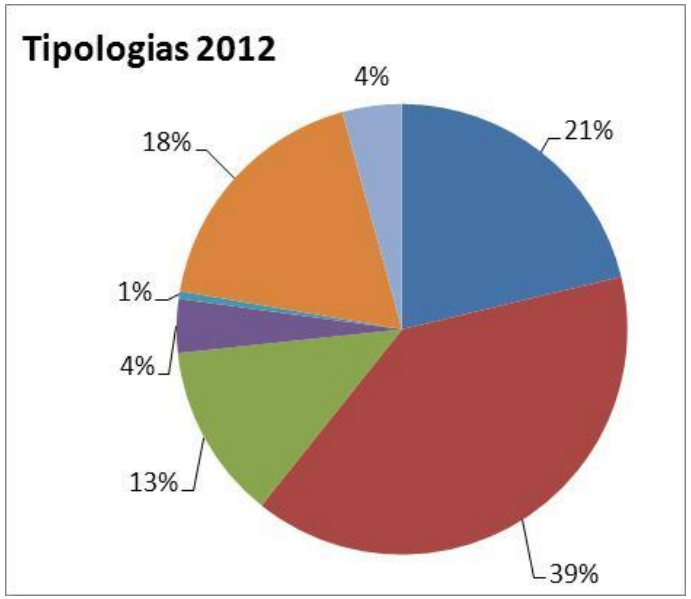
Before and after ZER – Emissions (Lisbon Center)

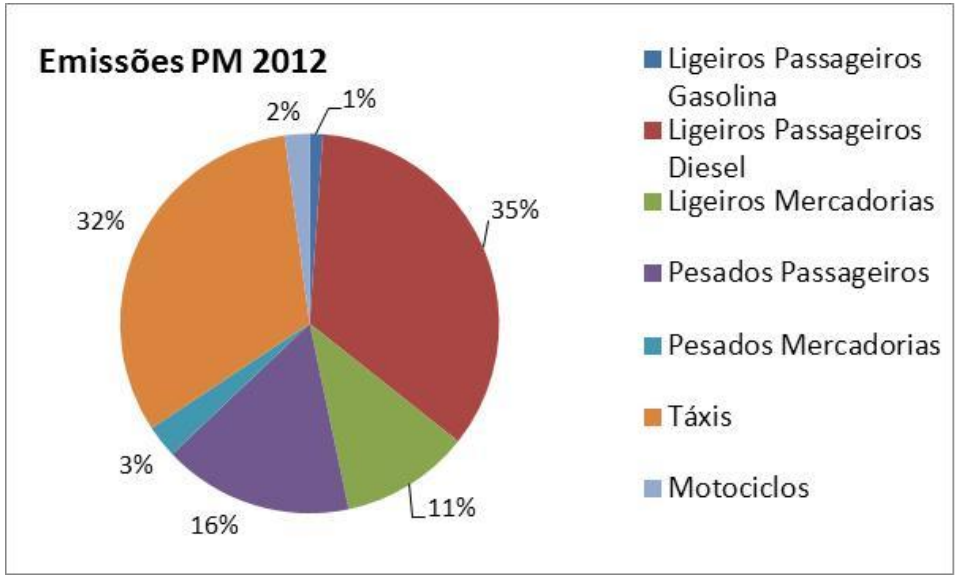
Less cars, modern fleets = **less emissions**

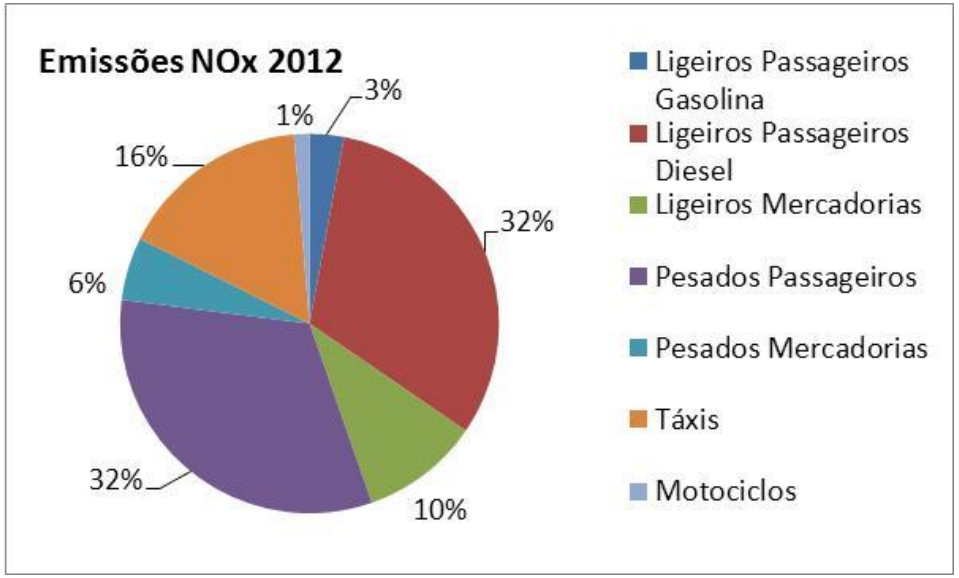




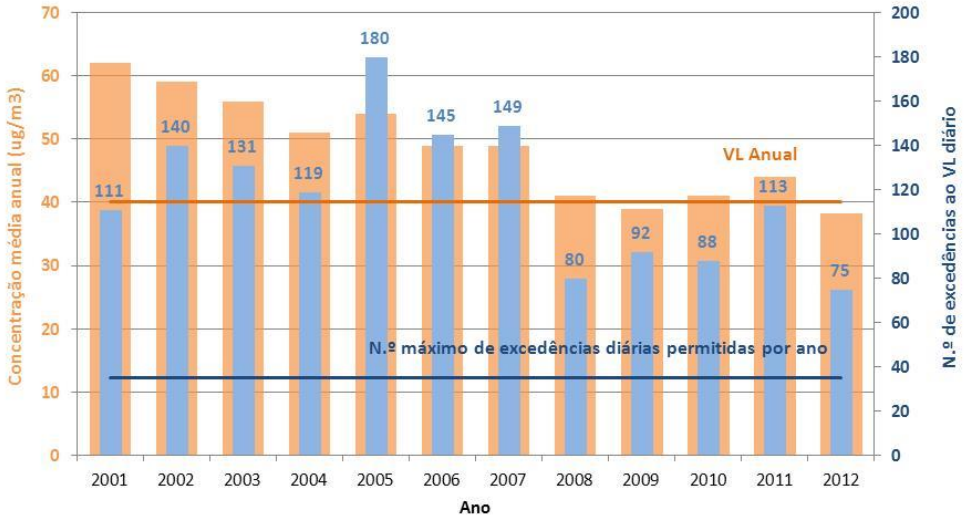
Before and after ZER – Emissions (Lisbon Center)





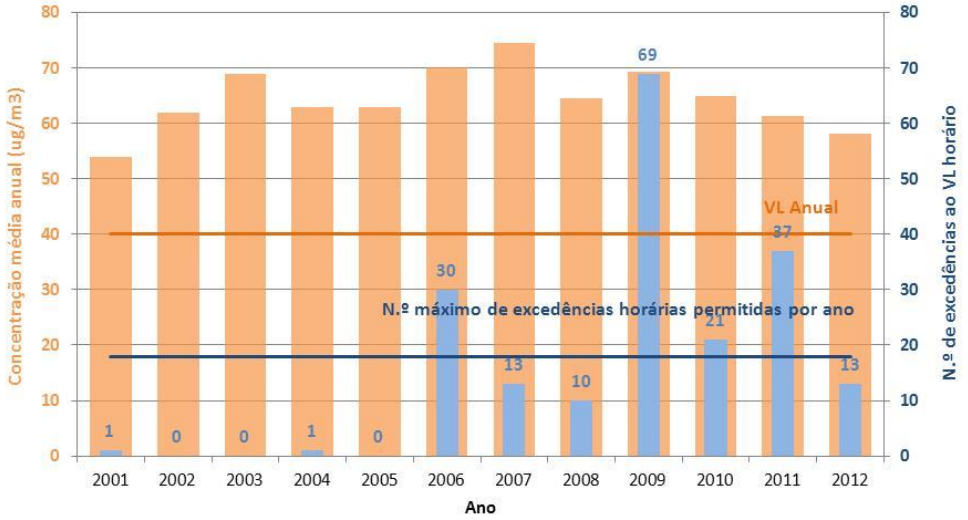
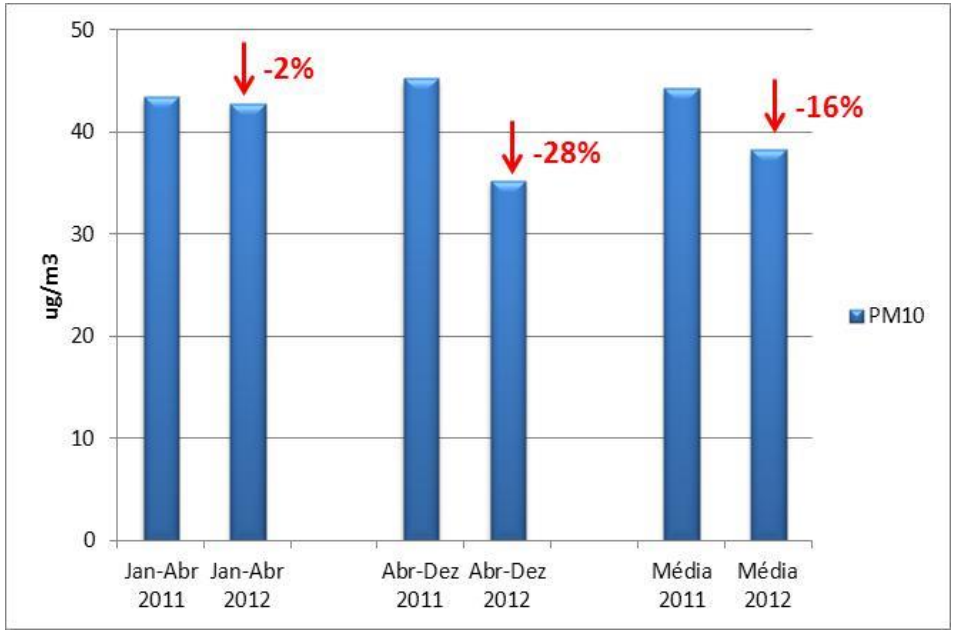
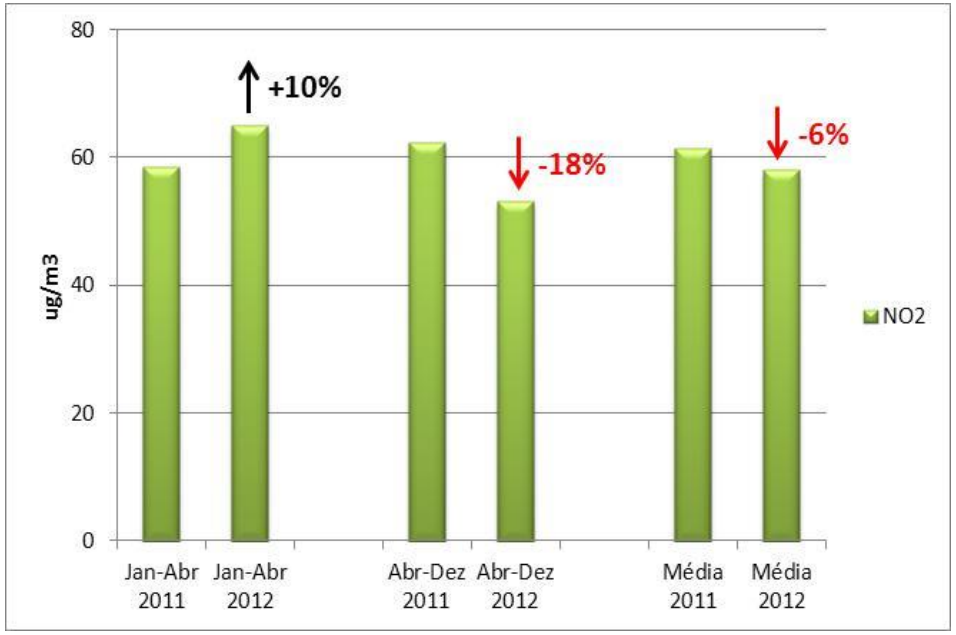


Avenida da Liberdade – 2001/2012



PM10

NOx



Before and after ZER Phaase II (AVL)