Contribution to:

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OPERATIONAL SHORT TERM HEALTH IMPACT ASSESMENT OF AIR POLLUTION MODELLING SYSTEM OVER EUROPE

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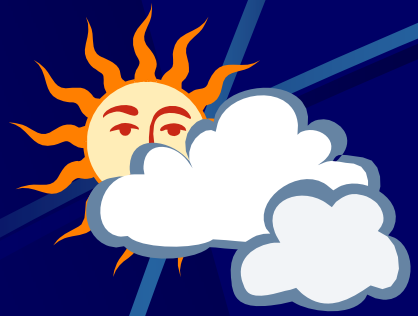
http://artico.lma.fi.upm.es

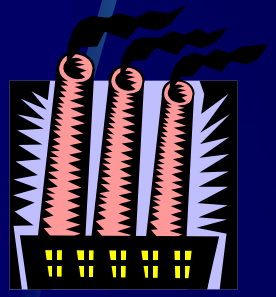
METHODOLOGY

AIR QUALITY



HEALTH IMPACT FUNCTIONS

HEALTH



HEALTH IMPACT FUNCTIONS

Mortality Change = Air Pollution Change * Mortality Effect Estimate * Mortality Incidence * Exposed Population

- **Air Pollution Change (ΔPM): Difference between the initial air pollution concentration and the air pollution concentration after some change (specific period of time).**

- **Mortality Effect Estimation (Beta): Percentage change in mortality due to one unit change in ambient air pollution.**

- **Mortality Incidence(y_0): Average number of people who die in a given population over a given period of time.**

- **Exposed Population: Number of people affected by the air pollution change.**

>>>>>>> % / (period of time)

DERIVING HEALTH IMPACT FUNCTIONS

1. CHOOSE A FUNCTIONAL FORM OF THE RELATIONSHIP BETWEEN CONCENTRATION AND HEALTH EFFECT. THIS IS THE C-R (CONCENTRATION-RESPONSE) FUNCTION. LOG-LINEAR REGRESSION (POISSON) IS THE MOST COMMON FORM.

2. ESTIMATE THE VALUES OF THE PARAMETER IN THE ASSUMED C-R FUNCTION, BASED ON DATA FROM EPIDEMIOLOGICAL STUDIES.

3. DERIVE THE RELATIONSHIP BETWEEN CONCENTRATION CHANGE (AC) AND MORTALITY CHANGE (AY) FROM THE C-R FUNCTION. THIS IS THE FINAL HEALTH IMPACT FUNCTION

LOG-LINEAR MODEL (POISSON)

$$\ln(y) = \alpha + \beta\, PM$$

□ = □ □

$$\Delta\square = \square\, E\square - \square F = \square(\square - \square)$$

y: Incidence rate

B: Incidence rate of y when the concentration is zero

α : Ln (B)

β : Parameter to adjust

PM: Concentration

y_0 : Baseline incidence rate of the health effect

β ESTIMATION. EPIDEMILOGICAL STUDIES

THE EPIDEMIOLOGICAL STUDIES DO NOT REPORT THE β PARAMETER OF THE C-R FUNCTION. THEY REPORT THE RELATIVE RISK (RR) ASSOCIATED WITH A GIVEN CHANGE IN THE POLLUTANT CONCENTRATION.

RR = POPULATION AFFECTED / TOTAL BASELINE POPULATION

$$\beta = \frac{\ln(RR)}{\Delta PM}.$$

ΔPM: Concentration change

EUROPEAN EPIDEMIOLOGICAL STUDIES. RR

EUROPEAN EPIDEMIOLOGICAL STUDIES. RR

META-ANALYSIS OF TIME-SERIES STUDIES AND PANEL STUDIES OF PARTICULATE MATTER (PM) AND OZONE (O3)

H. Ross Anderson, Richard W. Atkinson, Janet L. Peacock, Louise Marston and Kostas Konstantinou

Part of the WHO project “Systematic review of health aspects of air pollution in Europe”, which is funded by the European Commission and is intended to provide input to the Clean Air For Europe (CAFE) programme

HELTH EFFECTS:

- **Mortality for all causes**
- **Mortality for respiratory causes**
- **Mortality for cardiovascular causes**

POLLUTANS:

- **PM10 Daily average and O3 Maximum daily 8-hour mean**
- **Without reference concentrations for the RR calculations**

SPANISH EPIDEMIOLOGICAL STUDY. EMECAM PROJECT

EMECAM PROJECT: Spanish Multicenter Study on the Relationship Between Air pollution and the Mortality.

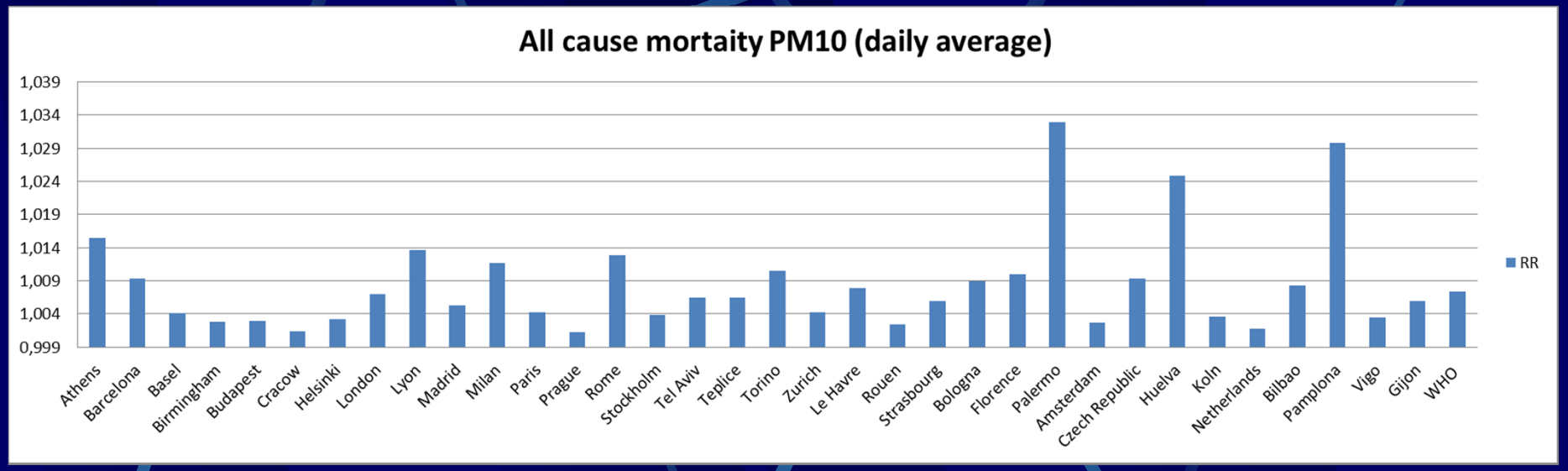
Data published in: Rev. Esp. Salud Pública 1999.Nº2 March-April

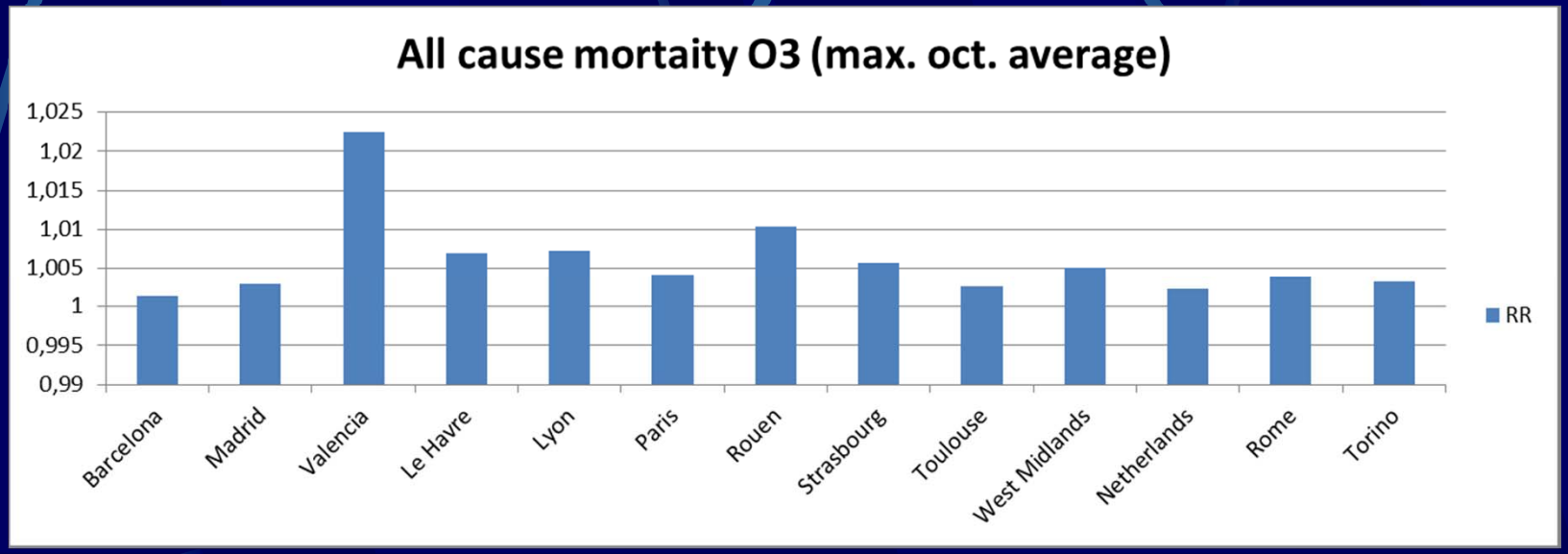
CITIES: Barcelona, Bilbao, Cartagena, Castellón, Gijón, Huelva, Madrid, Pamplona, Sevilla, Oviedo, Valencia, Vigo, Vitoria, Zaragoza.

TIME PERIOD: 1990 – 1996 . Between 3 and 5 years. It depends on the city.

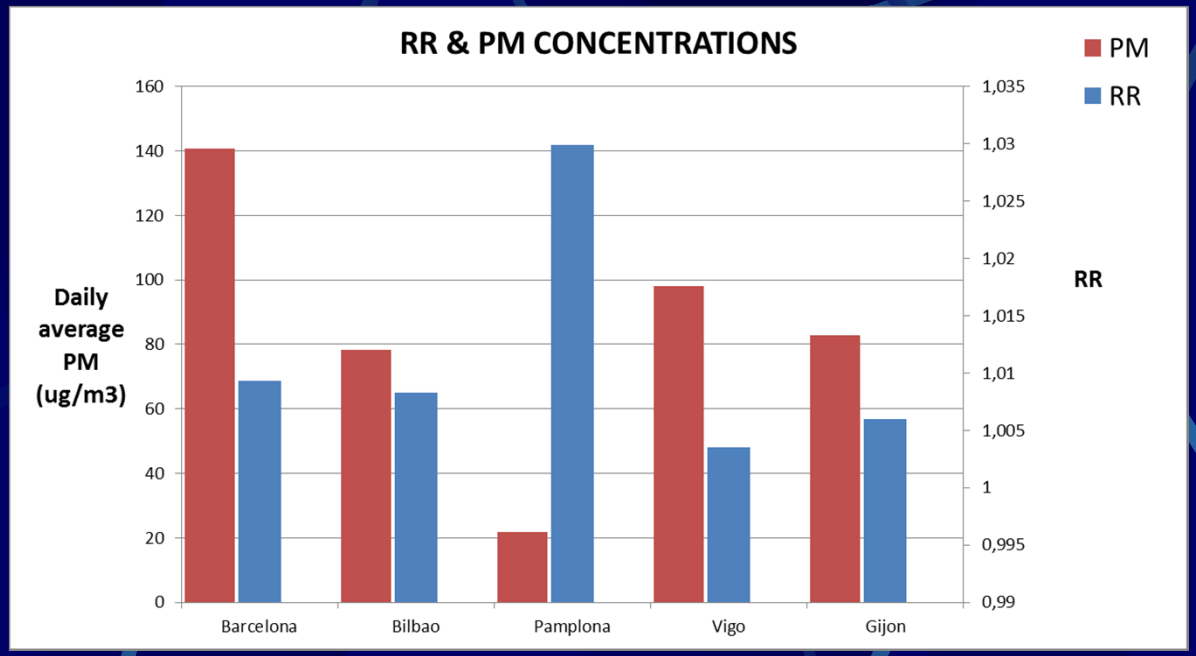
METHODOLOGY: Time series data are taking the daily deaths, pollutants and other factors (Flu deaths). Analysis Poisson Regresion.

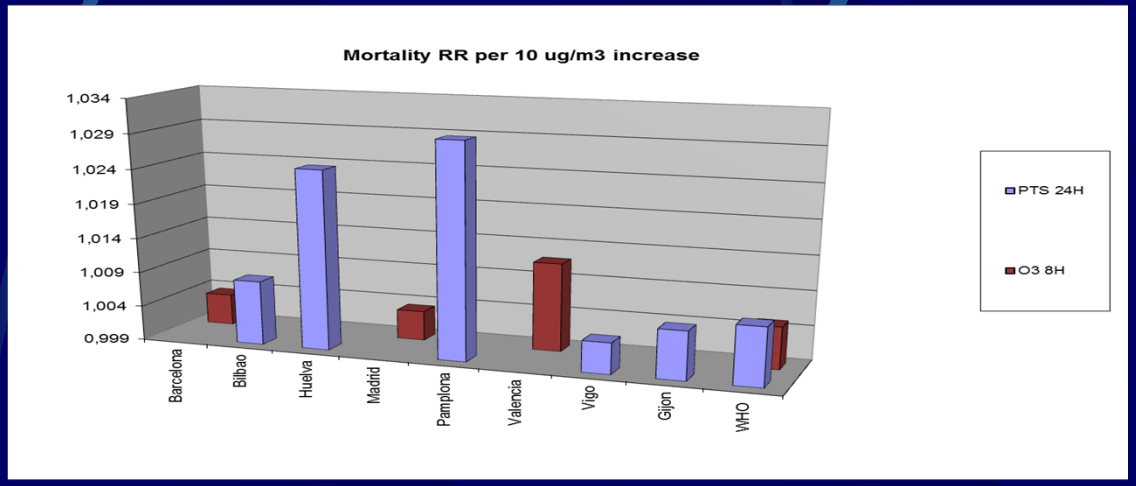
EPIDEMIOLOGICAL STUDIES. RR





SPANISH EPIDEMIOLOGICAL STUDIES. RR





For the non Spanish cities, values of concentrations are taken from the EUROPEAN OPERATIONAL AIR QUALITY FORECASTS SYSTEM.

The values are updated daily

SHORT-TERM IMPACT FORECAST OF AIR POLLUTION ON THE MORTALITY. EUROPEAN CASE STUDY

FINAL PRODUCT: Forecast of the European mortality change (%) for tomorrow related to today's mortality due to air pollution concentration changes

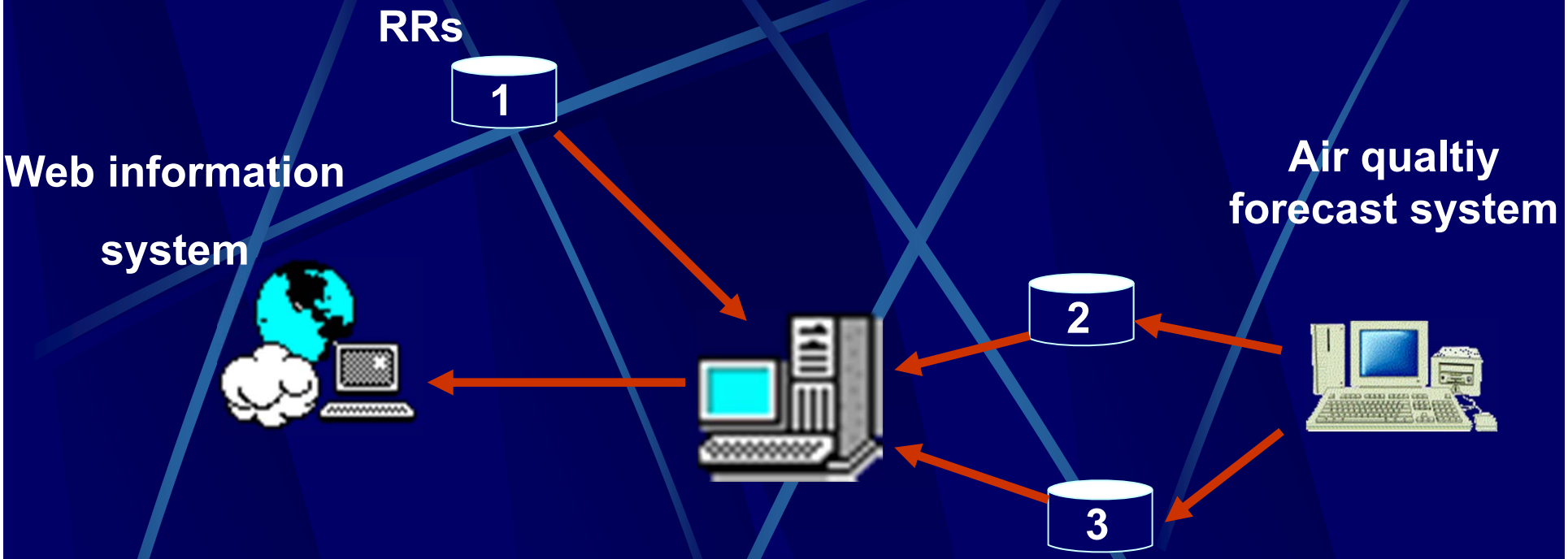
3 Health effects:

- **Mortality for all causes**
- **Mortality for respiratory causes**
- **Mortality for cardiovascular causes**

2 Air pollution indicators:

- **Daily average PM10**
- **Maximum daily 8-hour mean: O3**

DATA SOURCES



1. RR from epidemiological studies
2. Air pollution over European cities of the epidemiological studies.
3. Air quality forecast for today and tomorrow 50 Km resolution.
   Source: UPM MM5-CMAQ European Air quality System
   (http://verde.lma.fi.upm.es/cmaq_eu)

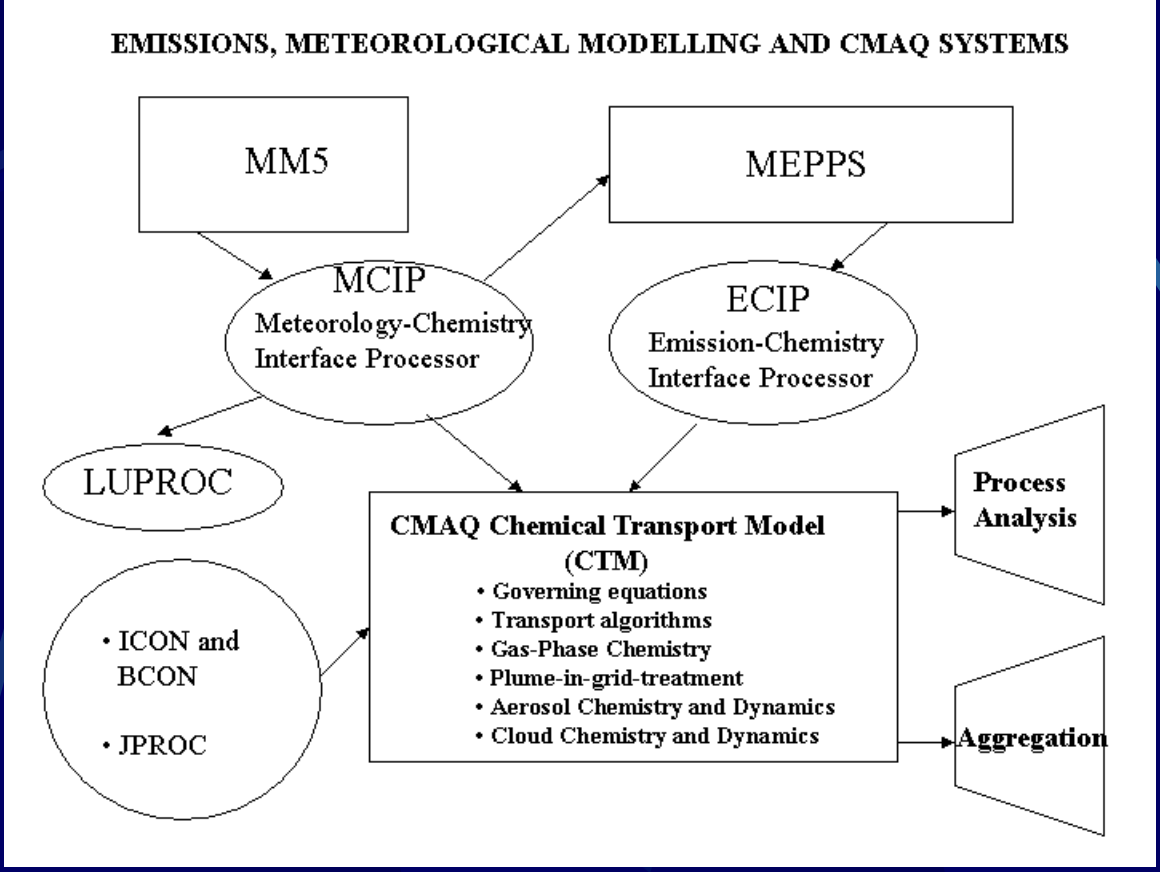
FLOW WORK

BY EACH GRID CELL AND HEALTH INDICATOR:

1. Search the city with air pollution levels close to the level of the grid cell. Choose the RR asociated to the selected city.
2. Calculate the concentration change between tomorrow and today.
3. Forecast the mortality change for tomorrow. Log-Linear model.
4. Write results

THE MM5-CMAQ MODELLING SYSTEM

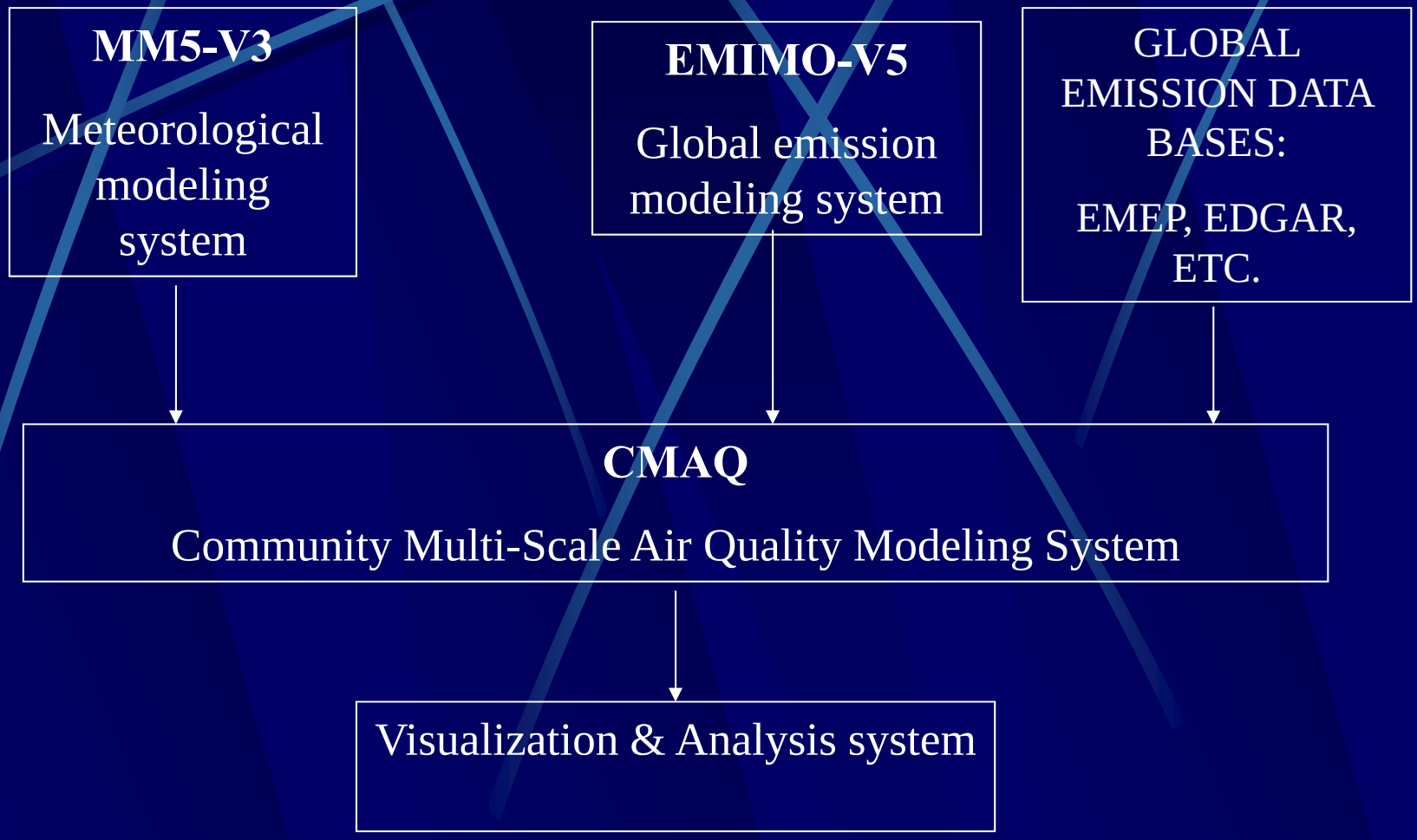
Models 3
EPA's Third Generation
Air Quality Modeling System

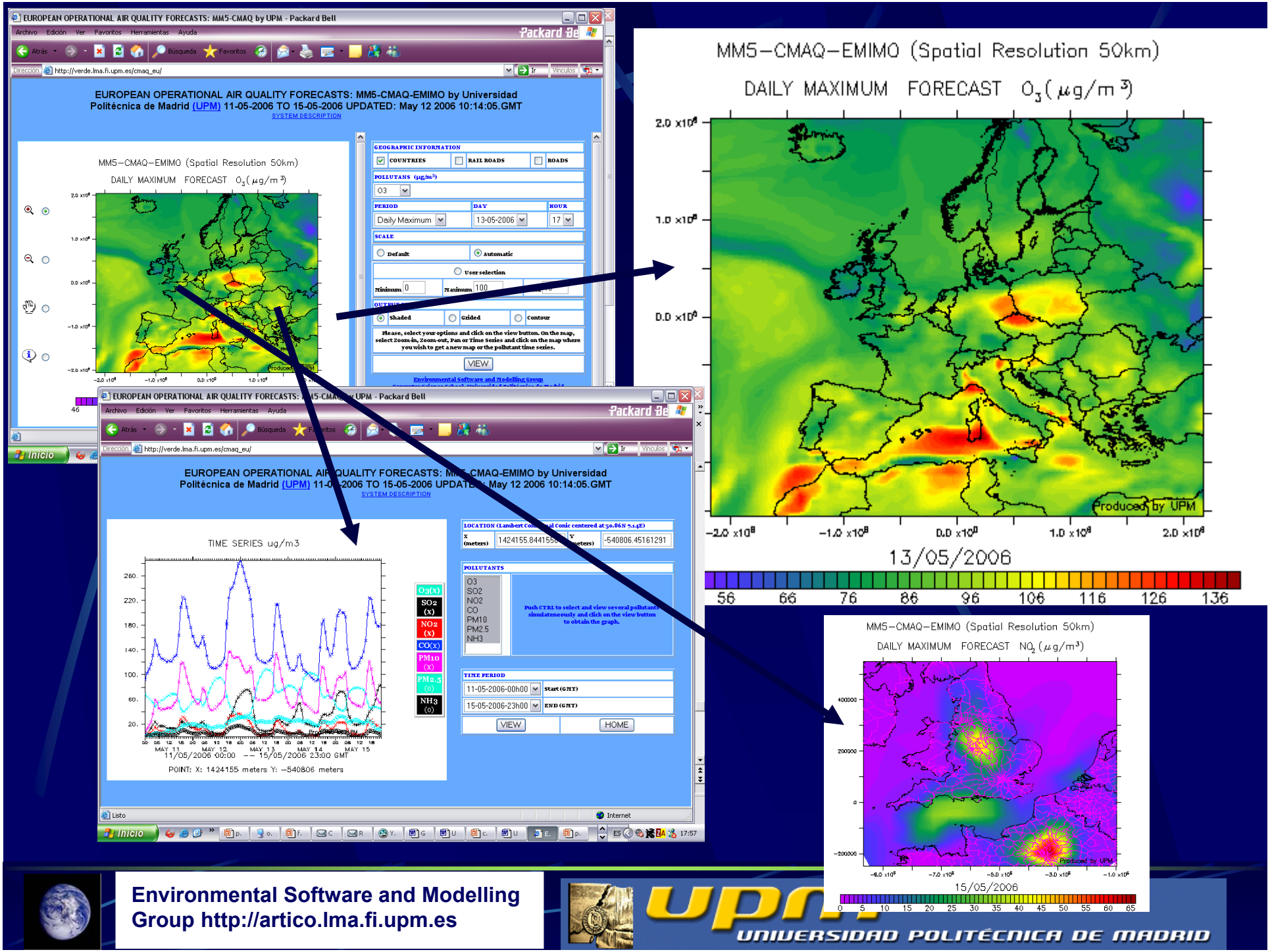


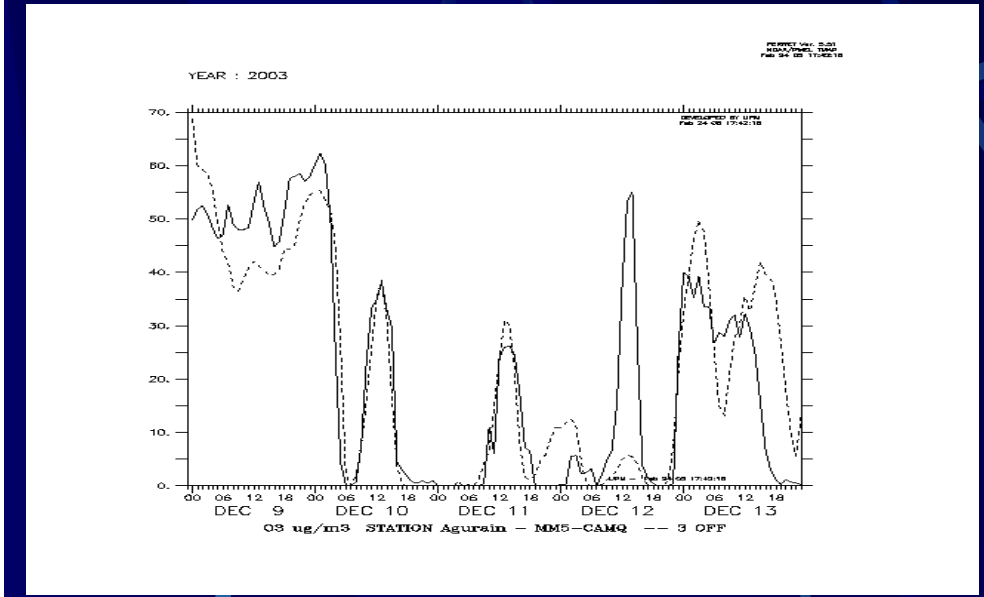
THE CMAQ MODEL:

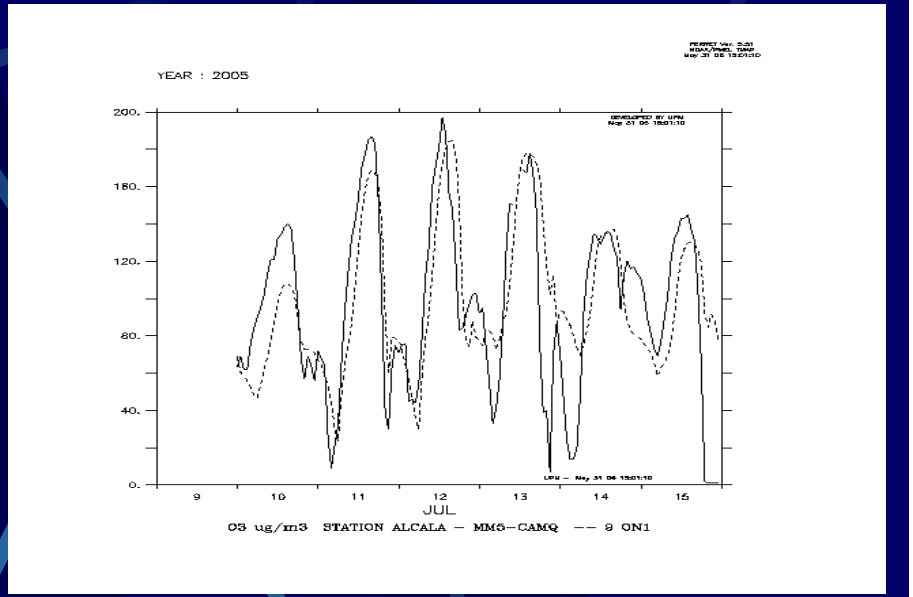
COMMUNITY MULTISCALE AIR QUALITY MODELING SYSTEM

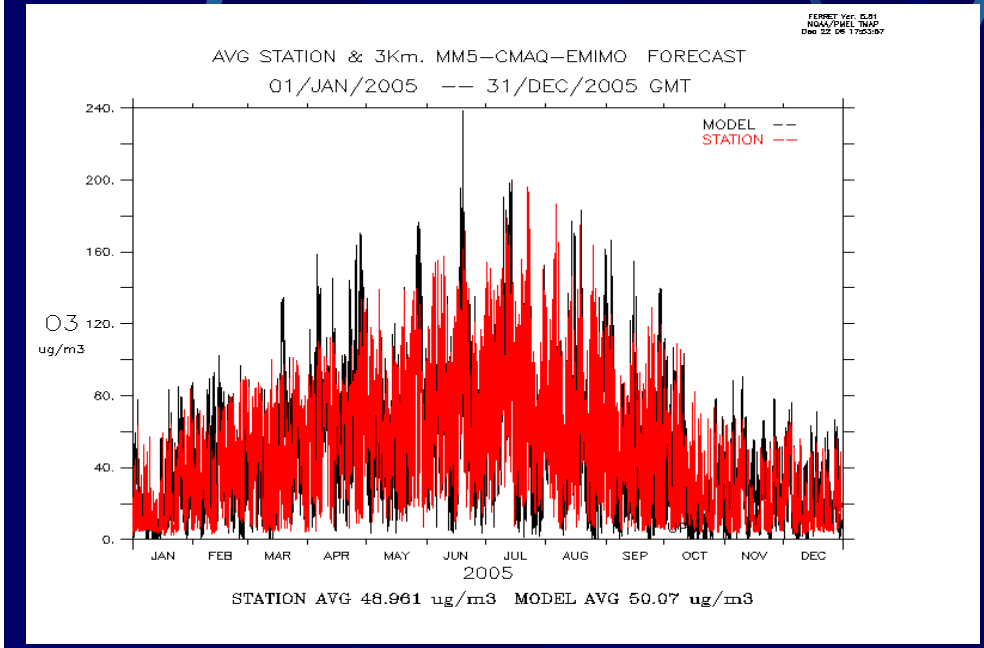
MM5-CMAQ-EMIMO MODELLING SYSTEM

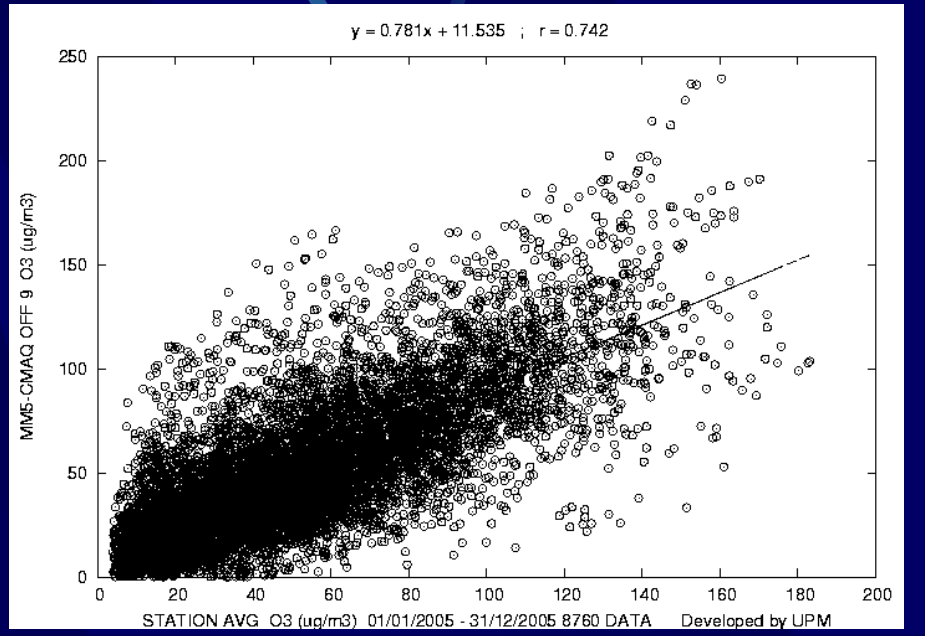


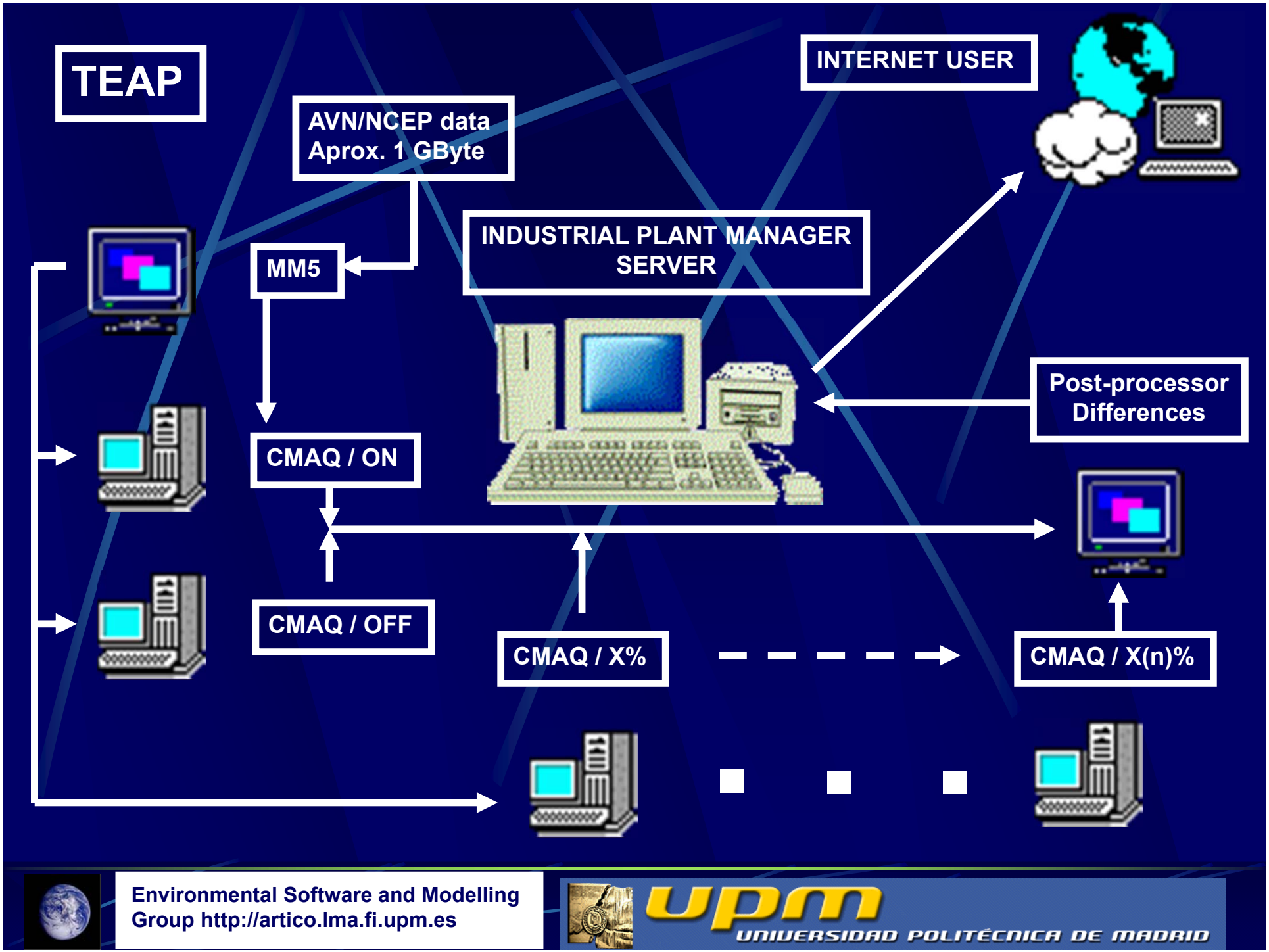

EUROPEAN OPERATIONAL AIR QUALITY FORECASTS: MM5-CMAQ by UPM - Packard Bell
EUROPEAN OPERATIONAL AIR QUALITY FORECASTS: MM5-CMAQ-EMIMO by Universidad Politécnica de Madrid (UPM) 11-05-2006 TO 15-05-2006 UPDATED: May 12 2006 10:14:05.GMT
SYSTEM DESCRIPTION
MM5–CMAQ–EMIMO (Spatial Resolution 50km)
DAILY MAXIMUM FORECAST O_3 (μg/m³)
GEOGRAPHIC INFORMATION
COUNTRIES
RAIL ROADS
ROADS
POLLUTANS (μg/m³)
O3
PERIOD
DAY
HOUR
Daily Maximum
13-05-2006
17
SCALE
Default
Automatic
User selection
Minimum 0
Maximum 100
Shaded
Gided
Contour
Please, select your options and click on the view button. On the map, select Zoom-in, Zoom-out, Pan or Time Series and click on the map where you wish to get a new map or the pollutant time series.
VIEW
Environmental Software and Modelling Group
Produced by UPM
13/05/2006
56 66 76 86 96 106 116 126 136
TIME SERIES ug/m3
POINT: X: 1424155 meters Y: -540806 meters
POLLUTANTS
O3
SO2
NO2
CO
PM10
PM2.5
NH3
Push CTRL to select and view several pollutants simultaneously and click on the view button to obtain the graph.
TIME PERIOD
11-05-2006-00h00
Start (GMT)
15-05-2006-23h00
END (GMT)
VIEW
HOME
MM5–CMAQ–EMIMO (Spatial Resolution 50km)
DAILY MAXIMUM FORECAST NO_2 (μg/m³)
15/05/2006
0 5 10 15 20 25 30 35 40 45 50 55 60 65
Environmental Software and Modelling Group http://artico.lma.fi.upm.es
UNIVERSIDAD POLITÉCNICA DE MADRID

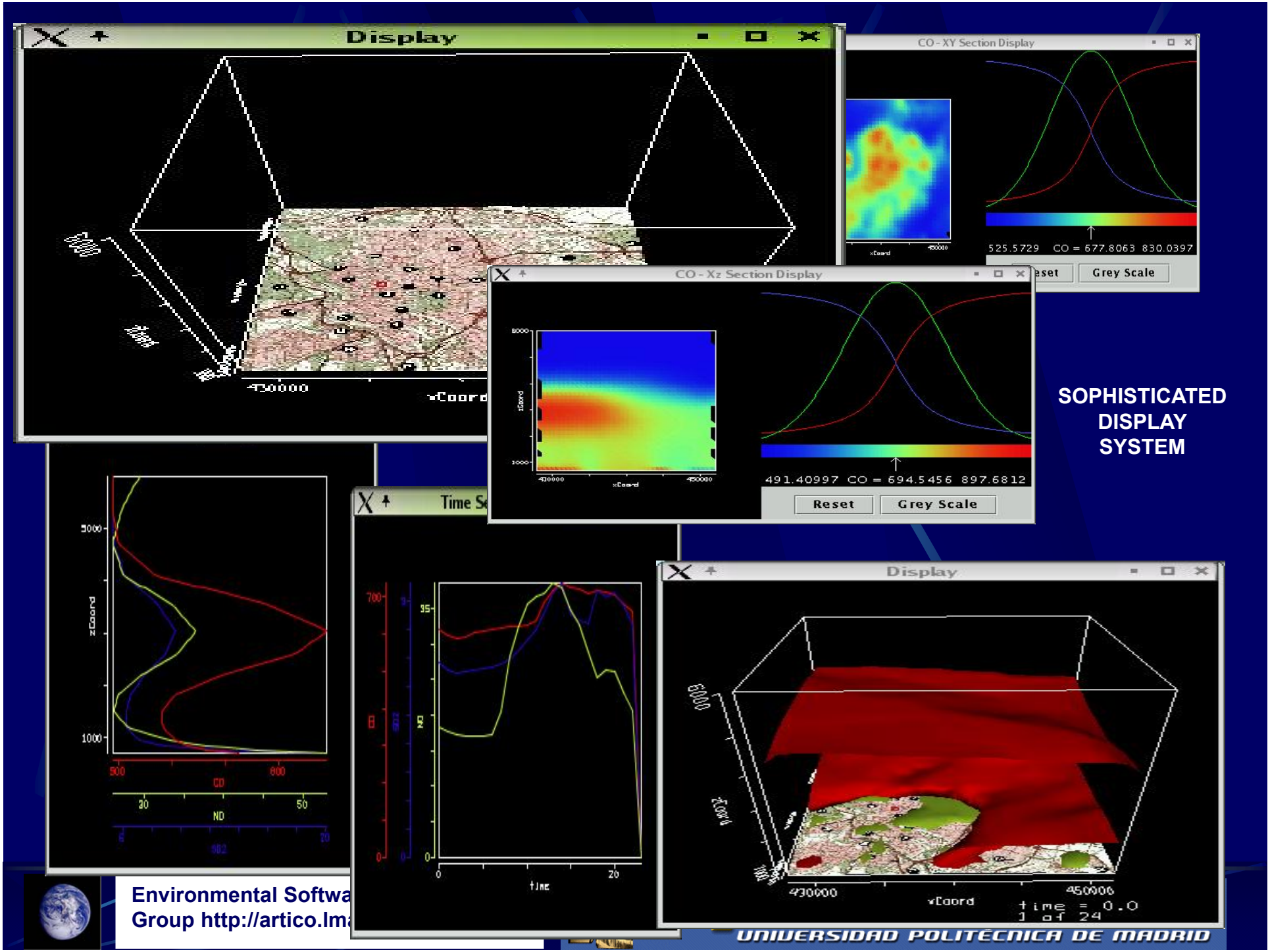

YEAR : 2003
DEC 9
DEC 10
DEC 11
DEC 12
DEC 13
O3 ug/m3 STATION Agurain — MM5—CAMQ -- 3 OFF


YEAR : 2005
JUL
O3 ug/m3 STATION ALCALA — MM5—CAMQ -- 9 ON1


AVG STATION & 3Km. MM5—CMAQ—EMIMO FORECAST
01/JAN/2005 -- 31/DEC/2005 GMT
MODEL --
STATION --
O3 ug/m3
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
2005
STATION AVG 48.961 ug/m3 MODEL AVG 50.07 ug/m3


y = 0.781x + 11.535 ; r = 0.742
MM5-CMAQ OFF 9 O3 (ug/m3)
STATION AVG O3 (ug/m3) 01/01/2005 - 31/12/2005 8760 DATA
Developed by UPM


TEAP
AVN/NCEP data
Aprox. 1 GByte
INTERNET USER
MM5
INDUSTRIAL PLANT MANAGER
SERVER
Post-processor
Differences
CMAQ / ON
CMAQ / OFF
CMAQ / X%
CMAQ / X(n)%
Environmental Software and Modelling
Group http://artico.lma.fi.upm.es
upm
UNIVERSIDAD POLITÉCNICA DE MADRID


Display
CO - XY Section Display
525.5729 CO = 677.8063 830.0397
Grey Scale
CO - Xz Section Display
491.40997 CO = 694.5456 897.6812
Reset
Grey Scale
SOPHISTICATED
DISPLAY
SYSTEM
Time S
Display
6000
4000
2000
430000
450000
xCoord
time = 0.0
1 of 24
Environmental Softwa
Group http://artico.lm
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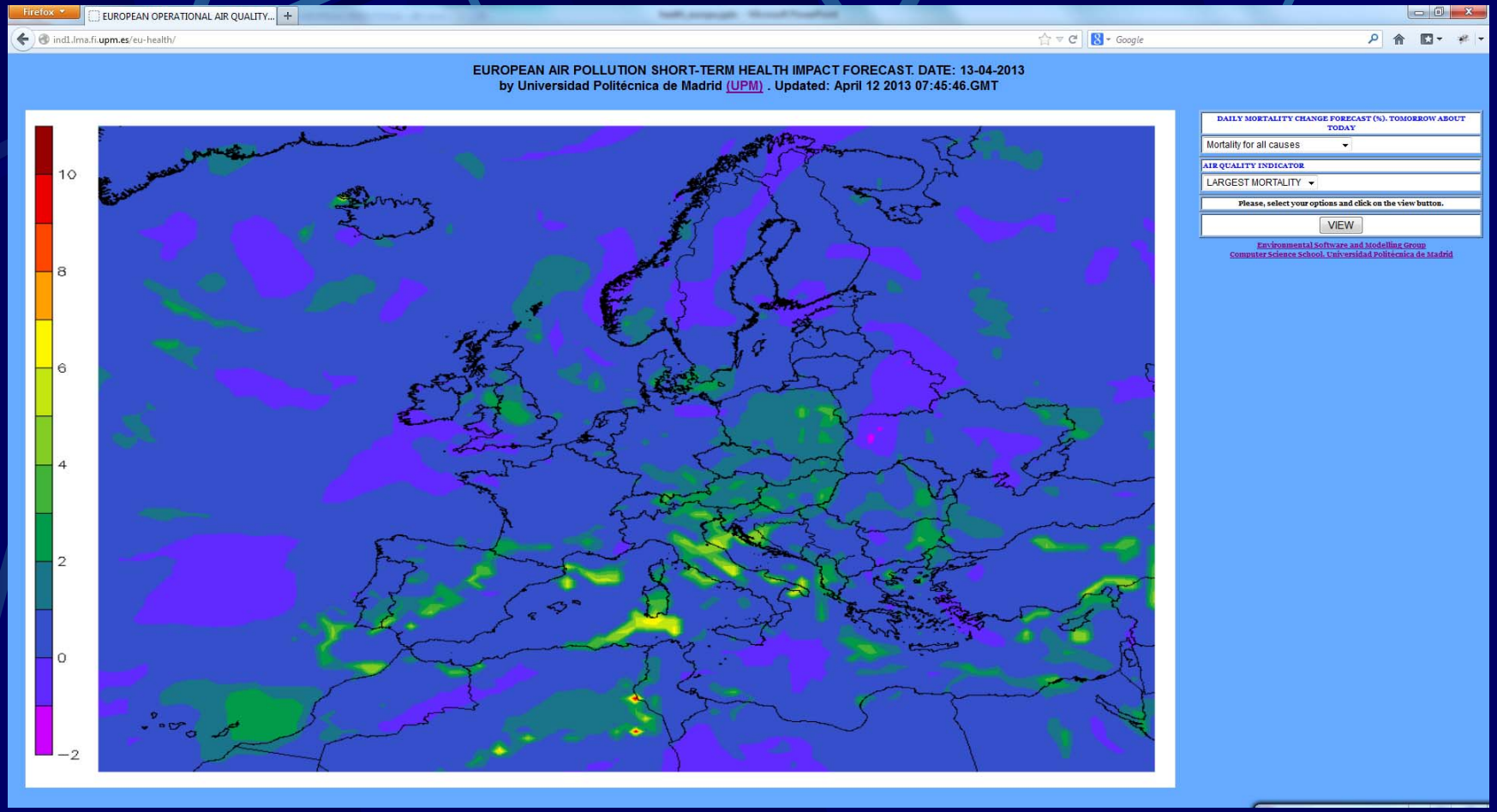
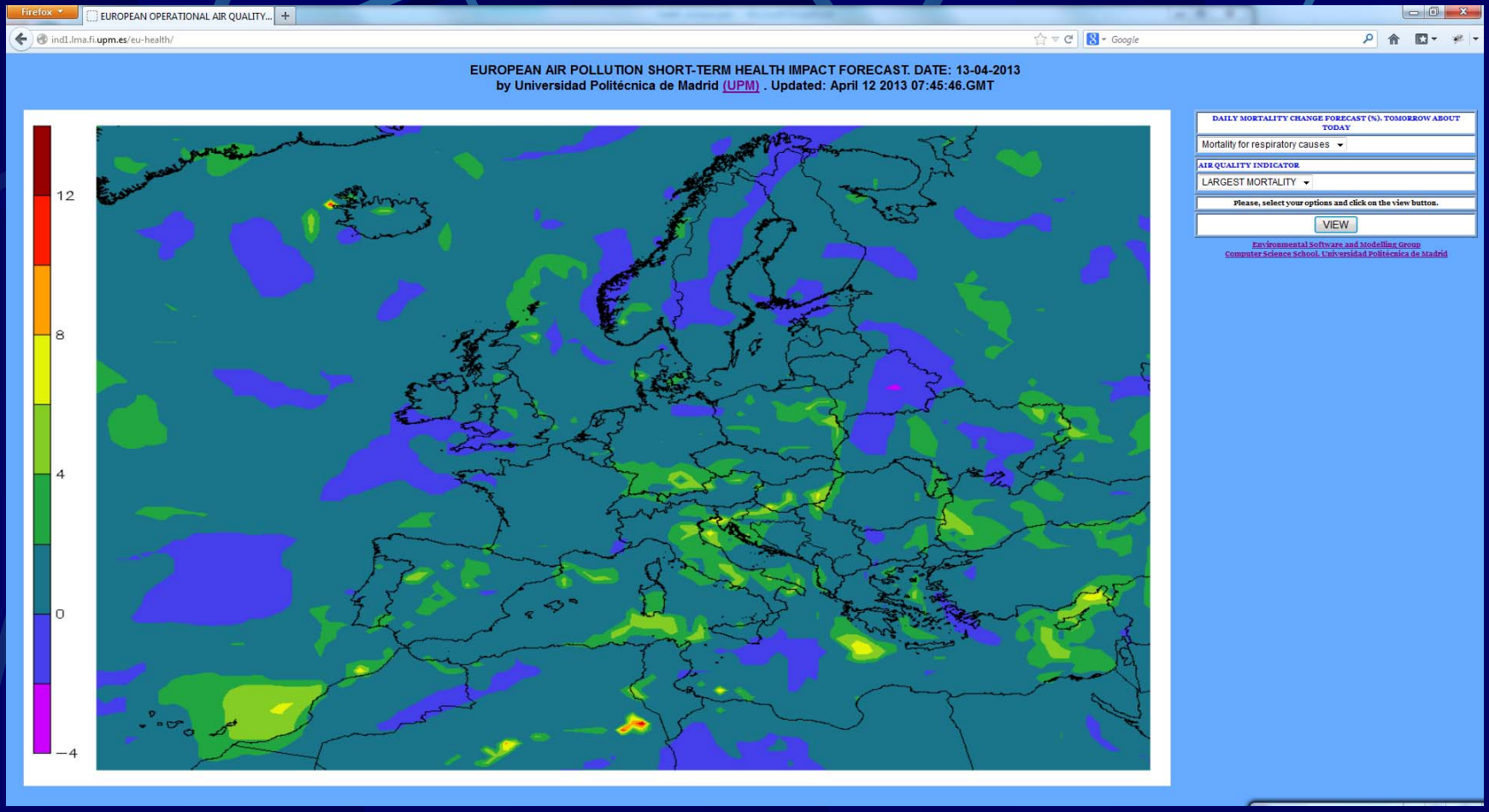
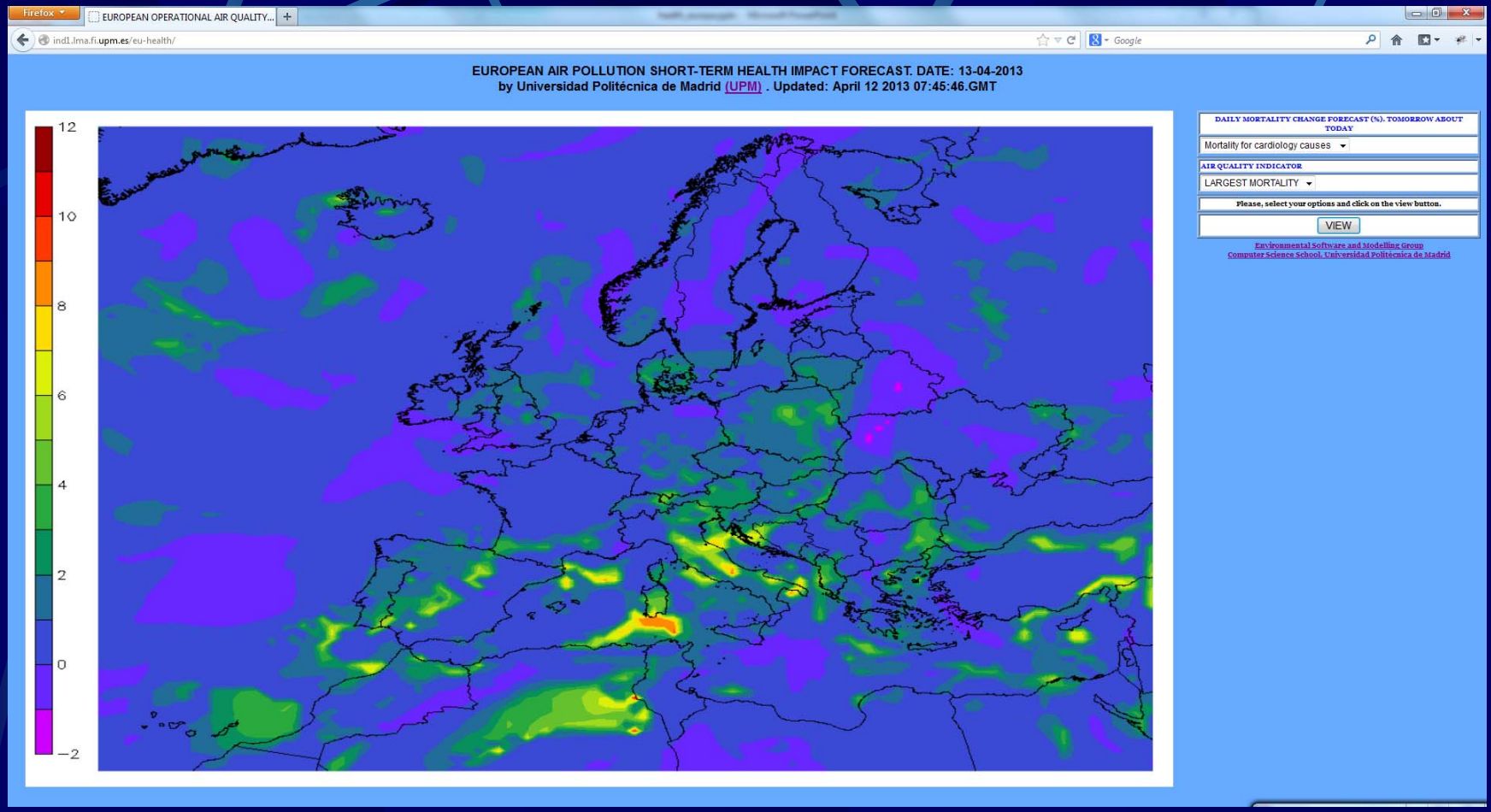
FORECAST DAILY MORTALITY CHANGE (%) FOR TOMORROW (12/04/2013) RELATED TO TODAY. MORTALITY ALL CAUSES. LARGEST MORTALITY AIR QUALITY INDICATOR



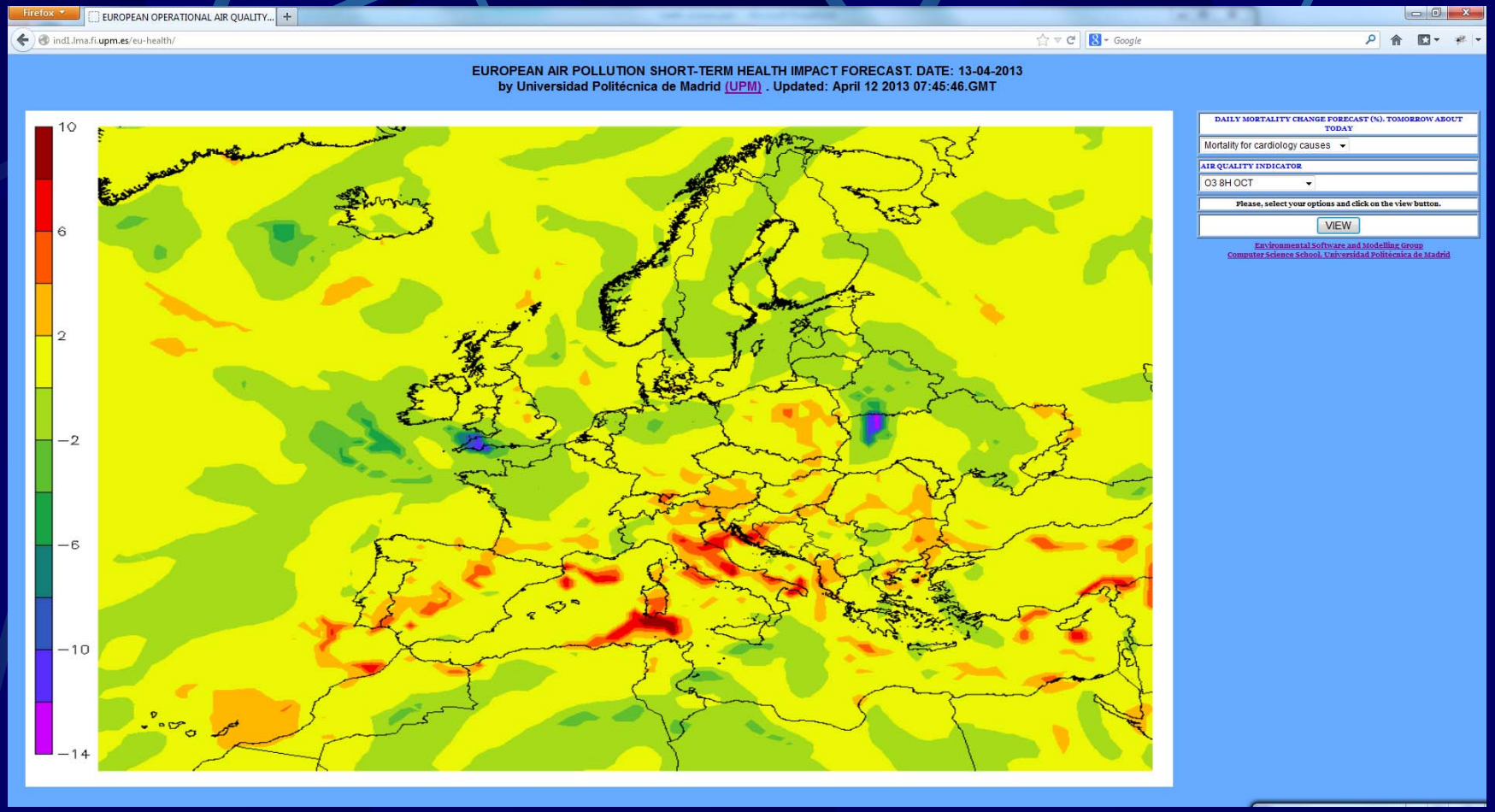
FORECAST DAILY MORTALITY CHANGE (%) FOR TOMORROW (12/04/2012) RELATED TO TODAY. MORTALITY FOR RESPIRATORY CAUSES. LARGEST MORTALITY AIR QUALITY INDICATOR



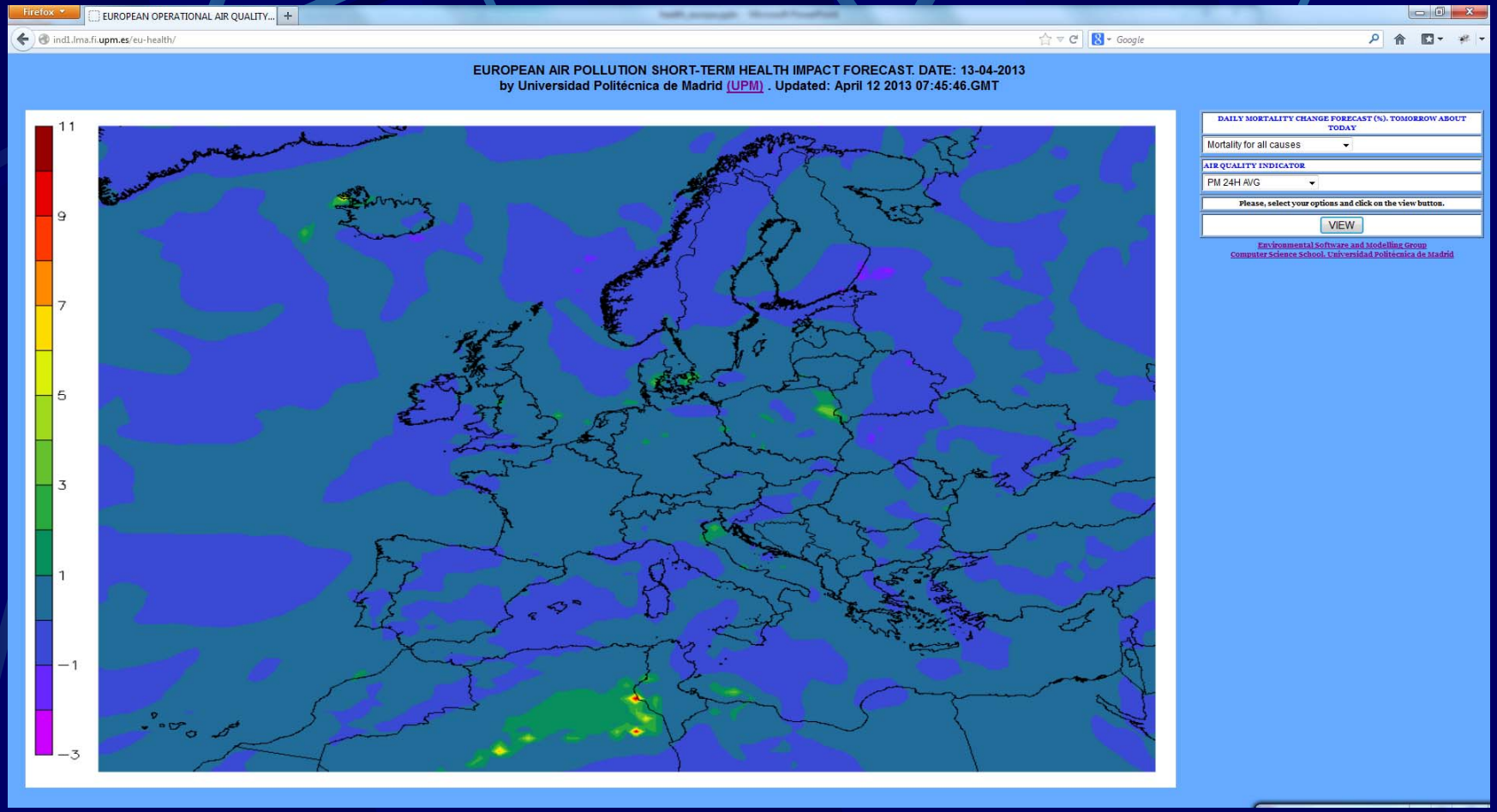
FORECAST DAILY MORTALITY CHANGE (%) FOR TOMORROW (12/04/2013) RELATED TO TODAY. MORTALITY FOR CARDIOLOGY CAUSES. LARGEST MORTALITY AIR QUALITY INDICATOR



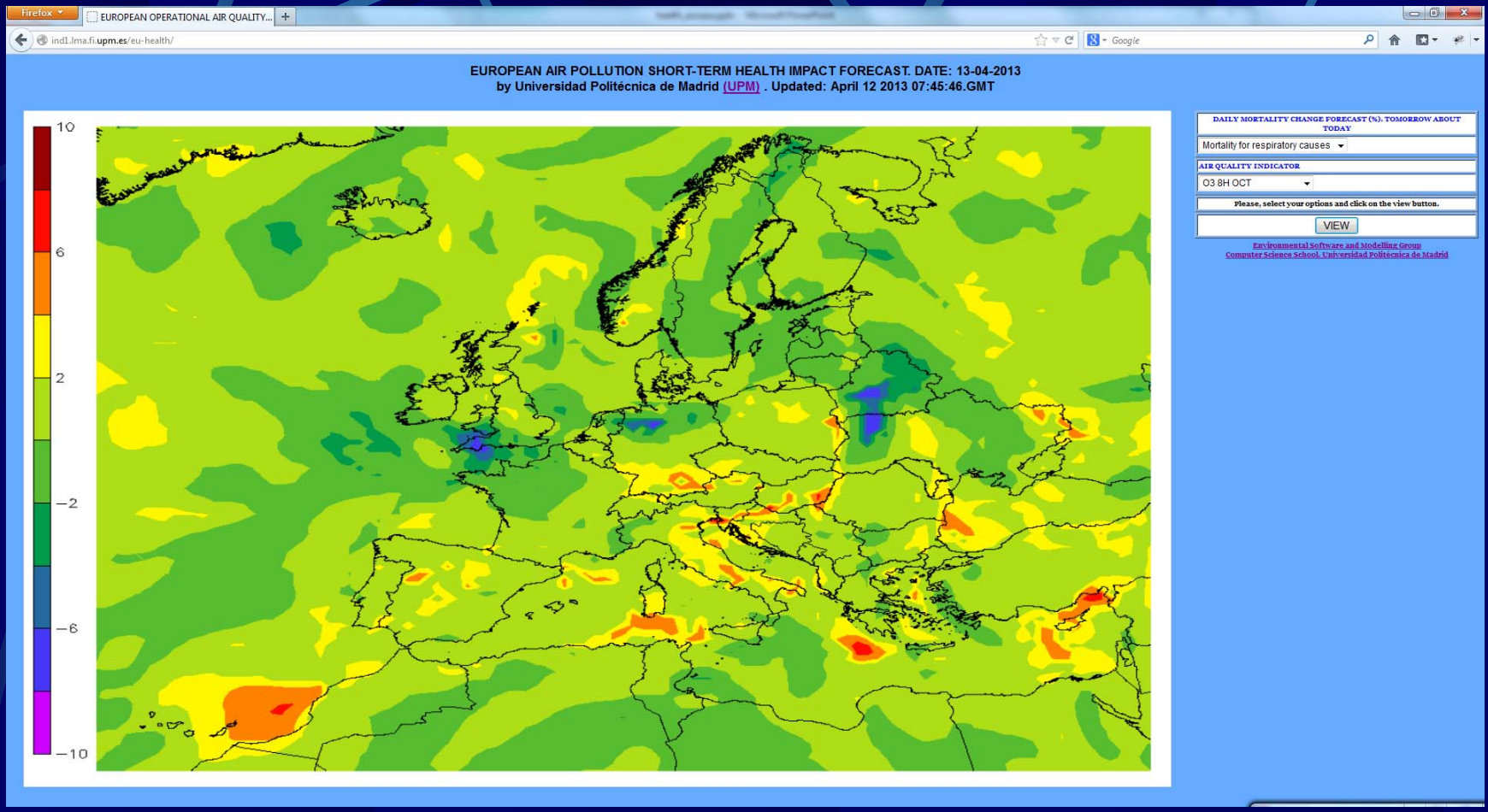
FORECAST DAILY MORTALITY CHANGE (O3) (%) FOR TOMORROW (12/04/2013) RELATED TO TO TODAY. MORTALITY FOR CARDIOLOGY CAUSES. O3 8H AIR QUALITY INDICATOR



FORECAST DAILY MORTALITY CHANGE (PM10) (%) FOR TOMORROW (12/04/2013) RELATED TO TODAY. MORTALITY FOR ALL CAUSES. PM10 24 H. AVERAGE AIR QUALITY INDICATOR



FORECAST DAILY MORTALITY CHANGE (O3) (%) FOR TOMORROW (12/04/2013) ABOUT TODAY. MORTALITY FOR RESPIRATORY CAUSES. O3 8H. MORTALITY AIR QUALITY INDICATOR



OPERATIONAL FORECAST DAILY MORTALITY CHANGE (%) FOR TOMORROW RELATED TO TO-TODAY'S MORTALITY.

http://ind1.lma.fi.upm.es/eu-health

Login requests: roberto@fi.upm.es

CONCLUSIONS

1. We have developed an operational health impact system based on the MM5-CMAQ operational air quality forecasts over all Europe with 50 km spatial resolution.

2. Results show a high sensitivity to the dynamical meteorology and chemical components in the atmosphere.

3. The impact of air pollution in the mortality is very important (percentages higher than 20 % are very common)

ACKNOWLEDGEMENTS

1. INDRA S.A.

2. ESPAÑA VIRTUAL CENIT PROJECT FUNDED BY MINISTRY OF INDUSTRY (2009-2012)