

**Contribution to:  
GURME Expert Workshop on Air Quality Forecasting.  
24-26, October, 2002, Cuernavaca (Mexico)**

**OPERATIONAL AIR QUALITY MODELLING OVER  
THE INTERNET:  
6 YEARS OF EXPERIENCE**

R. San José

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



**1980-1989**

- Ph. D at CIBA  
(Centro de Investigaciones  
de la Baja Atmosfera)  
(Low Atmospheric  
Research Center)

University of Valladolid (Spain)  
and Spanish Meteorological  
Institute.

- Micrometeorology
- Spectral studies
- Deposition modelling



**Environmental Software and Modelling Group  
started on February, 1993 at the Computer Science School of the  
Technical University of Madrid**



**1989: Max Planck Institute for Meteorology (Hamburg, Germany)  
(mesoscale modelling).**

**1990-92: IBM-Bergen Environmental Sciences and Solution Center  
(Barcelona Olympic Games Modelling Studies).**

**1992-96: Deposition Measurement studies (EU projects) and  
MEMO+SMVGEAR Development.**

**1996: OPANA model V 3.0 (REMEST + SMVGEAR)**

**1997-98: OPANA model V4.0 (REMEST+VGEAR+AVN/MRF)**

**1999: RSM Model**

**2000-01: MM5 Model**

**2002: MM5-CMAQ Modelling System**



## OPANA MODEL V3.0 (I)

- The OPANA model is a visual interface (Tcl/Tk) developed to manage the Meteorological and dispersion (chemical) Modules.
- 1996 (version 3.0) adapts MEMO model (REMEST) and SMVGEAR (CHEMA) to create one FORTRAN-77 and 90 Code where SMVGEAR is a subroutine of MEMO (REMEST).
- This is an on-line (chemical solver is solved for every meteorological time step) version. The operational version Solves the chemistry every 1800 s.
- Biogenic emissions and off-line in the operational version.



## OPANA MODEL V3.0 (II)

- MEMO model is a limited area model so that general fluid partial differential equation system is solved without taking into account earth curvature.
- MEMO initialization is done by vertical meteorological soundings.
- In this version we used the upper-air observed meteorological data from Barajas International Airport in Madrid for the first 24 hours.
- For another domains, surface meteorological data was extrapolated up to 6000 m by using Monin-Obukhov theory.



## **EU projects supporting the Operational AQMS applications:**

- **EMMA: Integrated Environmental Monitoring Forecasting and Warning Systems in Metropolitan Areas.**  
**Funding: DGXIII- (IST) European Union.**  
**Period: 1995-98.**

**2. Electronic Services for a Better QUALity of Life (EQUAL).**  
**Funding: DGXIII- (IST) European Union.**  
**Period: 1998-2000.**

**3. APNEE: Air Pollution Network for Early warning and on-line information Exchange in Europe.**  
**Funding: IST-European Union.**  
**Period: Jan, 2000 – Dec. 2001.**



## **EU projects supporting the Operational AQMS applications:**

**4. APNEE-TU: Air Pollution Network for Early Warning and on-line information Exchange in Europe – Take-up.**

**Funding: IST-European Union. Period: April, 2002 – March, 2004.**

## **Other co-lateral European Union projects:**

**1. DECAIR : Development of an Earth Observation Data Converter with Application to Air Quality Forecast.**

**Funding: DGXII-(Environmental Research) European Union.  
Period: July, 1999 – July, 2002.**

**2. Optimised Expert System for Conducting Environmental Assessment of Urban Road Traffic (OSCAR).**

**Funding: Environment Programme – European Union.  
Period: September, 2002 – September, 2005**





## **Applications:**

- 1. Madrid City (EMMA and City Funding)**
- 2. Madrid Community (EMMA)**
- 3. Madrid Community (Internet Service Summer, 2000).**
- 4. Asturias (Spain) domain: Community of Asturias funding.**
- 5. Las Palmas de Gran Canaria (Cannary Islands, Spain):  
City Funding (OPANA V5.0: MM5-CMAQ). (off-line).**
- 6. Bilbao (Spain) (EQUAL project)**
- 7. Leicester City Council (U.K.) (EQUAL project)**
- 8. Leicester City Council (U.K.) (Internet service)**



## **Applications:**

**9. Andalucía (Spain) APNEE-TU European Project**

**10. Canary Islands Community (7 islands) APNEE-TU Project**

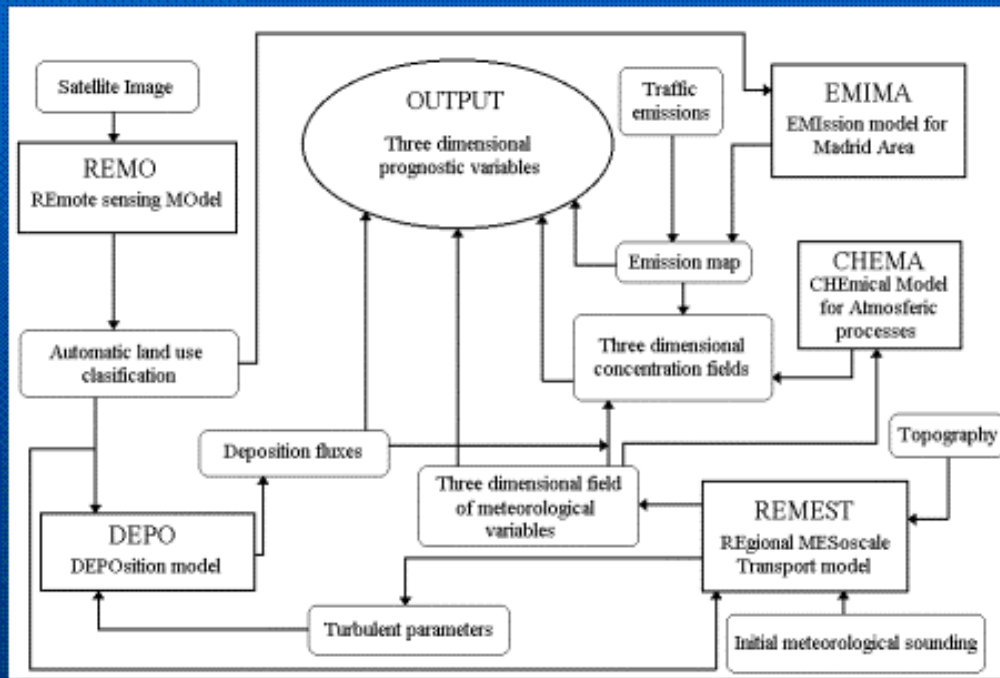
**11. Quito (Ecuador) (World Bank) 1998-2000.**





EMMA

# EMMA Model Structure



- Non hydrostatic mesoscale meteorological model.
- Eulerian transport model.
- Numerical photochemical model.
- High resolution emission model.
- Complex deposition resistance model.





EMMA

# Functional diagram

Sensors:

SO2  
NOX  
O3  
CO

Air quality stations

Emission factors

Traffic Departments  
Health Organisations,  
Research Institutions

EMMA

LAN

Environ. Adminin.

Sensors:

humid.  
wind  
temp.  
vert. meas.

Local meteo stations

Meteo Forecast

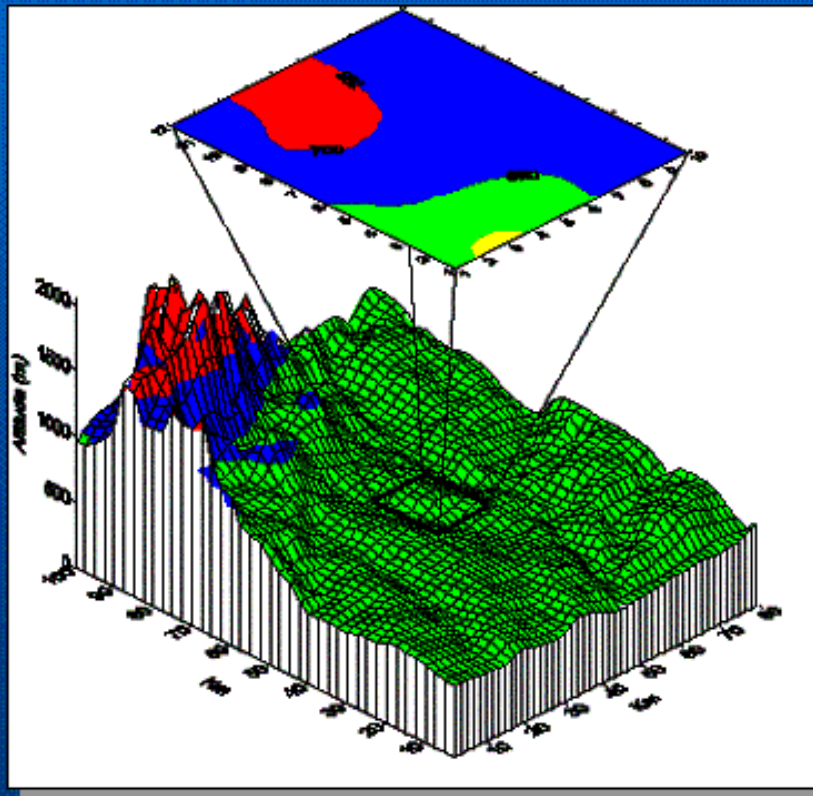
General public  
Displays, WWW, RDS-TMC





EMMA

# EMMA Domain Topography



## URBAN MODEL (EMMA\_U)

Area = 10x12 km

Grid = 10x12 cells

Resolution = 1 km

## REGIONAL MODEL (EMMA\_R)

Area = 80x100 km

Grid = 8x10 cells

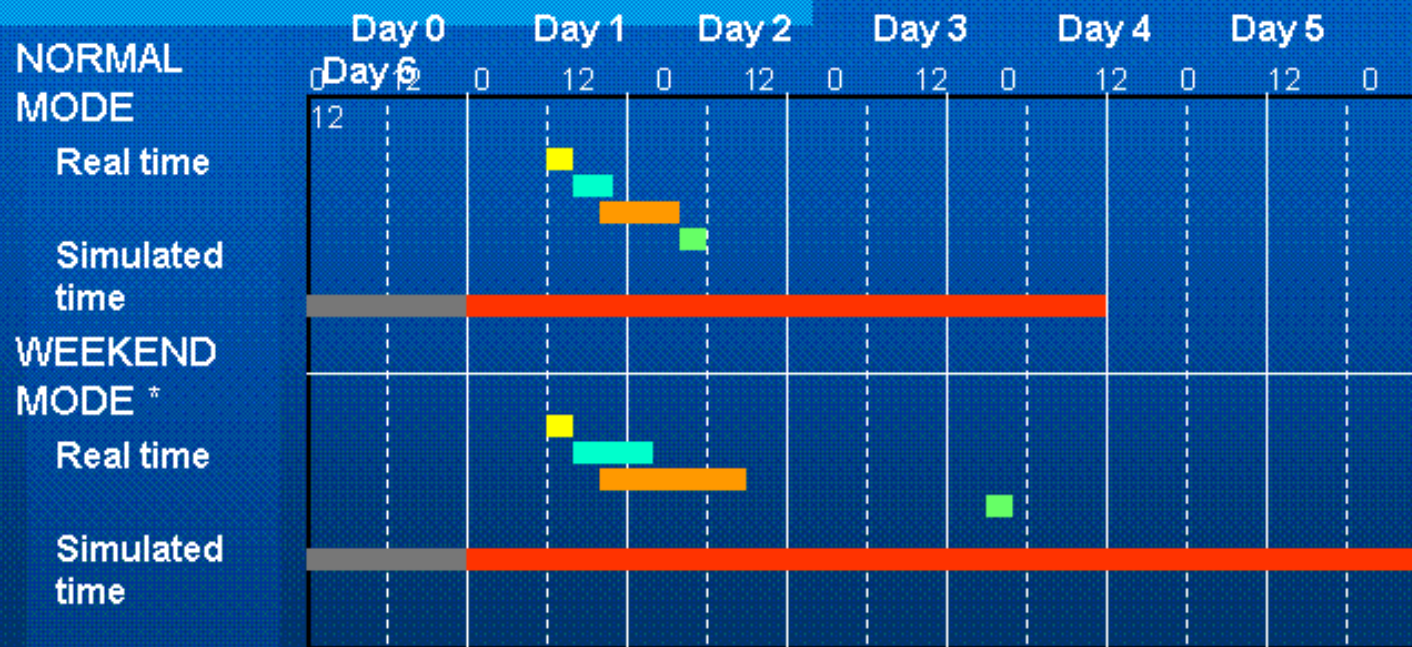
Resolution = 10 km



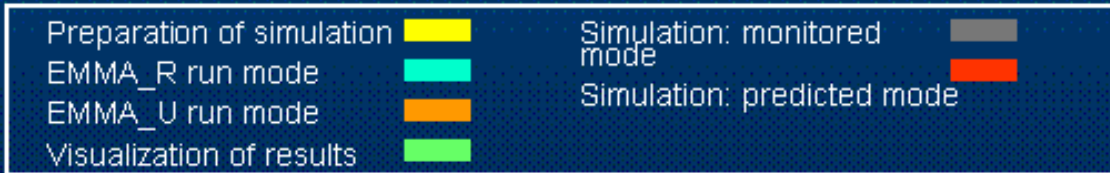


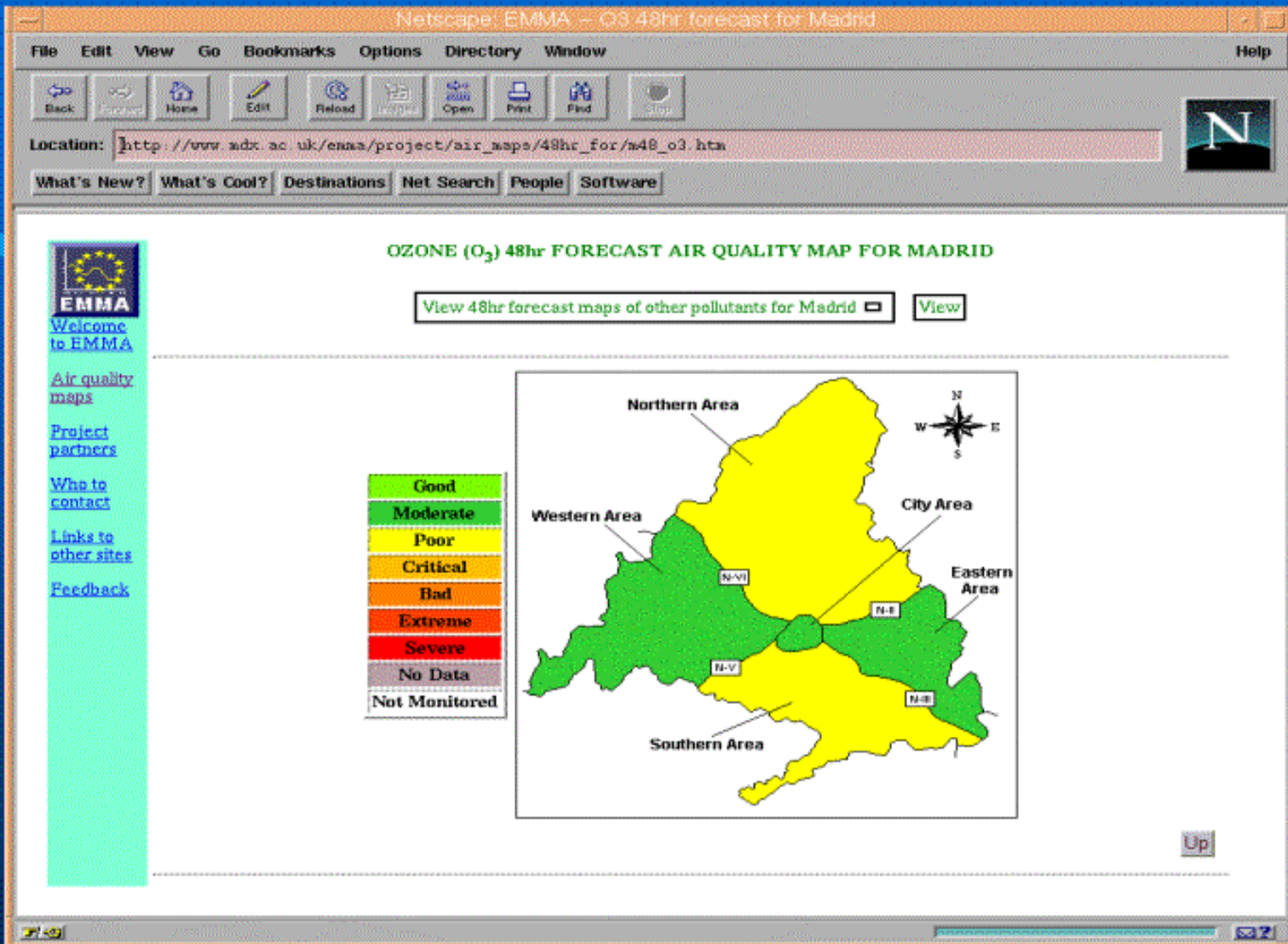
EMMA

# EMMA Operational Mode



\* In weekend mode  
Day 0=Thursday





# EQUAL EU Project



— EQUAL —  — Spain —



- Parking
- Public transport
- Traffic
- Environment
- Other local services
- Questionnaire

Evaluate Site

## A European Initiative

EQUAL is an acronym that stands for „Electronic Services for a Better **QUAL**ity of **LIF**e“, a European project that is co-funded by the EC within the DG XIII „Digital Sites“ frame-work and involves seven countries, which will carry out the EQUAL activities in six sites:

-  **UK / Leicester**  
Leicester City Council
-  **FR / Metz**  
Metz Ville
-  **IT /Brescia**  
ASM Brescia
-  **AT / Linz**  
Magistrat Linz
-  **ES / Bilbao**  
Ayuntamiento de Bilbao
-  **SE / Ronneby, DK / Bornholm**  
Ronneby Kommun,  
Trade and Industry  
Development Council of  
Bornholm





# EQUAL EU Project

— EQUAL — Spain —

- Museums
- Libraries
- Education
- Parking
- Public transport
- Traffic
- Environment**
- Other local services
- Questionnaire

BIZKAIA

Leicester

Site Developed By: [Environmental Software and Modelling Group](#)



# AVN/MRF GLOBAL METEOROLOGICAL INITIAL DATASETS



ARL Web Server



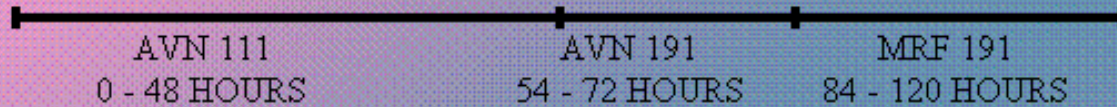
# AVN/MRF GLOBAL METEOROLOGICAL INITIAL DATASETS

MODEL	DOMAIN	TIME RUN (UTC)	FORECAST DURATION (h)	TEMPORAL RESOLUTION (h)	SPATIAL RESOLUTION (km)	OUTPUT RESOLUTION (km)	MODEL LEVELS
<u>RAMS FG</u>	<u>Variable</u>	12	36	1	4	4	25
<u>RAMS CG</u>	<u>Variable</u>	12	36	1	16	16	25
<u>Eta (40)</u>	<u>United States</u>	00/06/12/18	48	3	32	40	26
<u>Eta (91)</u>	<u>North America</u>	00/12	48	6	32	91	19
<u>NGM (91)</u>	<u>North America</u>	00/12	48	3	91	91	19
<u>RUC</u>	<u>United States</u>	0/3/6/9/12/15/18/21	12	3	40	40	26
<u>AVN</u>	<u>NH / SH</u>	00/06/12/18	84	6	~106	191	13
<u>AVN</u>	<u>NH</u>	00/06/12/18	48	3	~106	111	23
<u>MRF</u>	<u>NH / SH</u>	00	288	12	~106	191	13
<u>MM5</u>	<u>United States</u>	06/18	48	3	15	15	24
<u>MM5</u>	<u>North America</u>	00/06/12/18	72	3	45	45	24

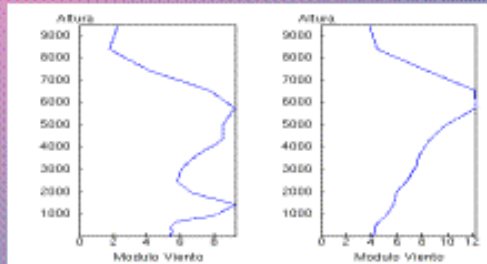




EQUAL - Spain



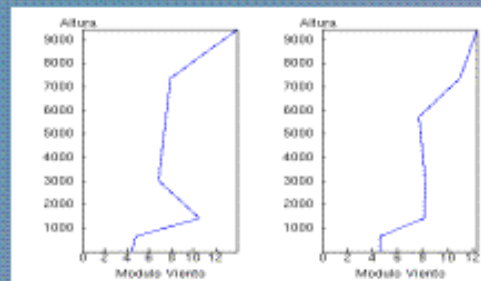
AVN 111



+6 hours

+12 hours

AVN 191



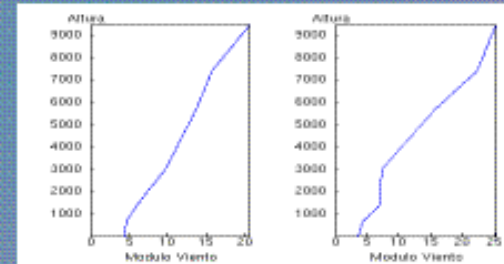
+54 hours

+60 hours

MRF 191

84 - 120 HOURS

MRF 191



+84 hours

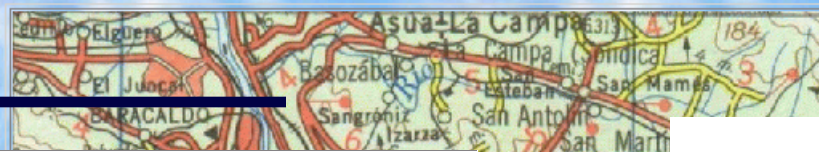
+96 hours

**Vertical  
Meteorological  
Soundings from  
AVN/MRF Models**



## OPANA Model Domain

Click on the map for source location.



Air Pollution Time Series location:

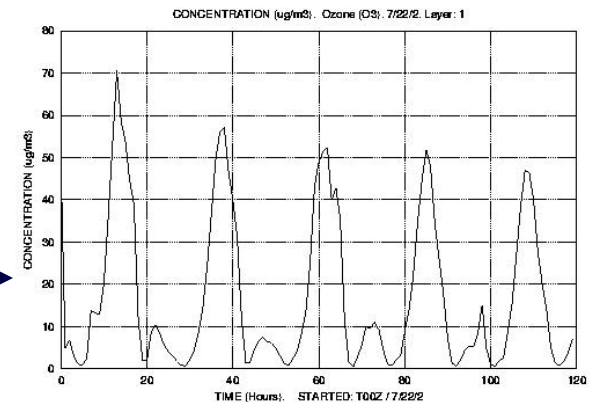
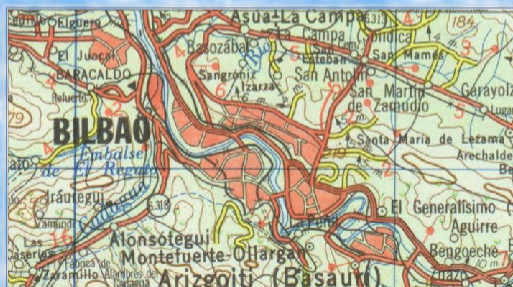
X:UTM: 503415 m ; Y:UTM: 4787856 m

Select an Air Pollution Time Series parameter or click on the map for source location.

User defined parameters to plot: Sulphur Dioxide (SO2) Height AGL: 10 Mts.

Units:  ug/m<sup>3</sup>  ppb

Request Air Pollution Time Series

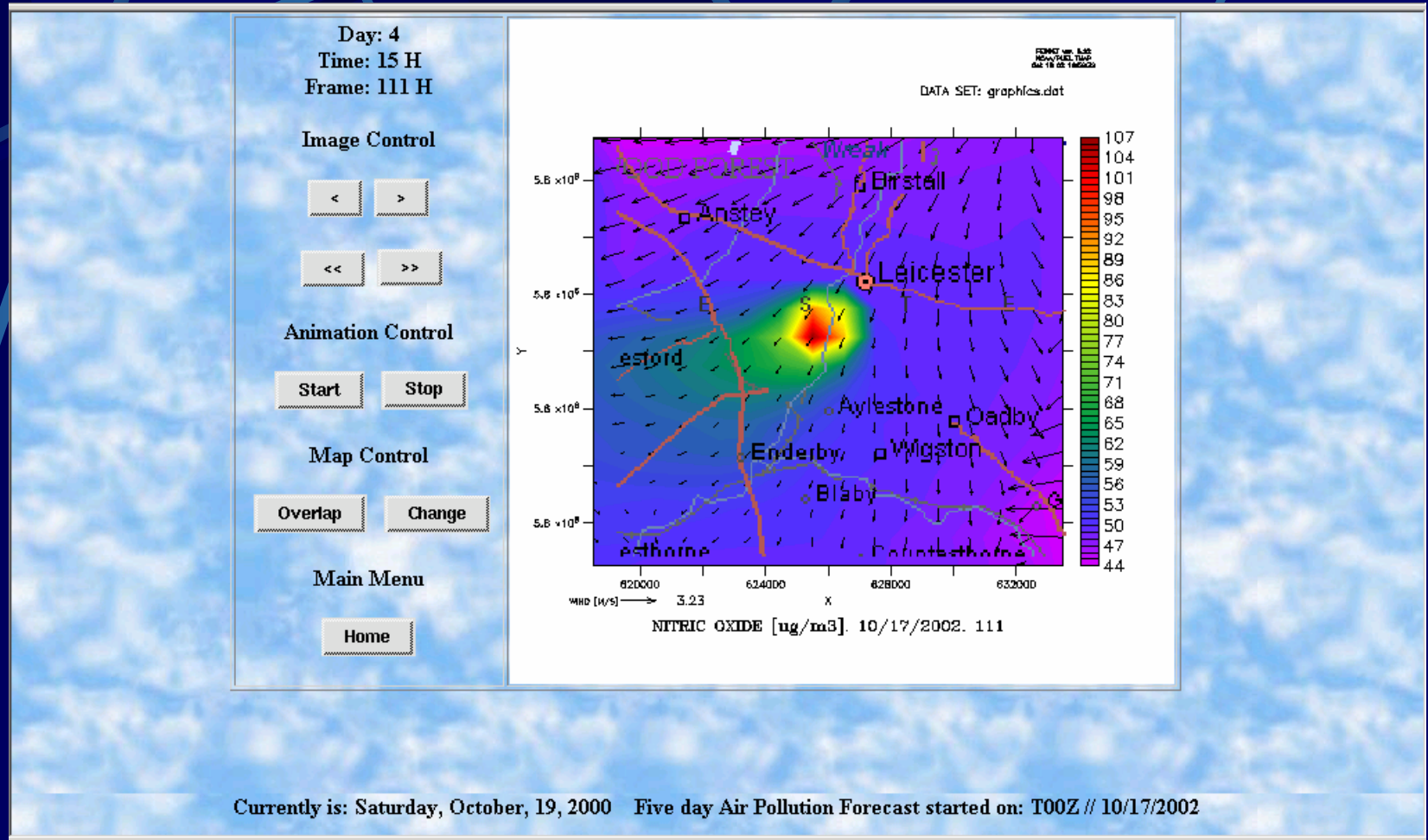


Pollution Forecast started on: T00Z // 22/ 7/2002

Currently is: Saturday, October, 19, 2001 Five day Air Pollution Forecast started on: T00Z // 22/ 7/2002



# EQUAL EU Project



# EQUAL EU Project

Air Pollution Time Series

XUTM: 624933 m ; YU

Select an Air Pollution Time Series parameter of

User defined parameters to plot:

- Sulphur Dioxide (SO2)
- Sulphur Dioxide (SO2)
- Nitrogen Dioxide (NO2)
- Nitrogen Dioxide (NO2)
- Ozone (O3)
- Carbon Monoxide (CO)

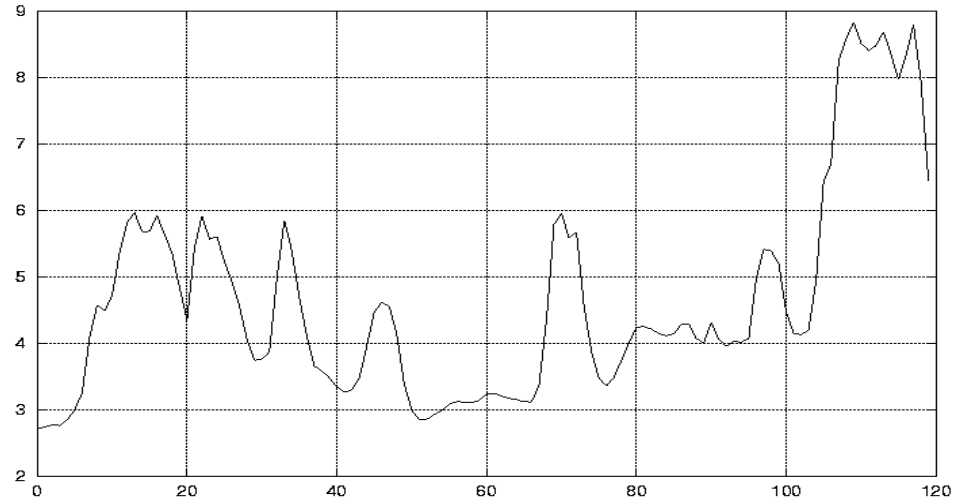
Units:

Request Air Pollution Time Series



Currently is: Saturday, October, 19, 2000 Five day Air Pollution Forecast started on: T00Z // 10/17/2002

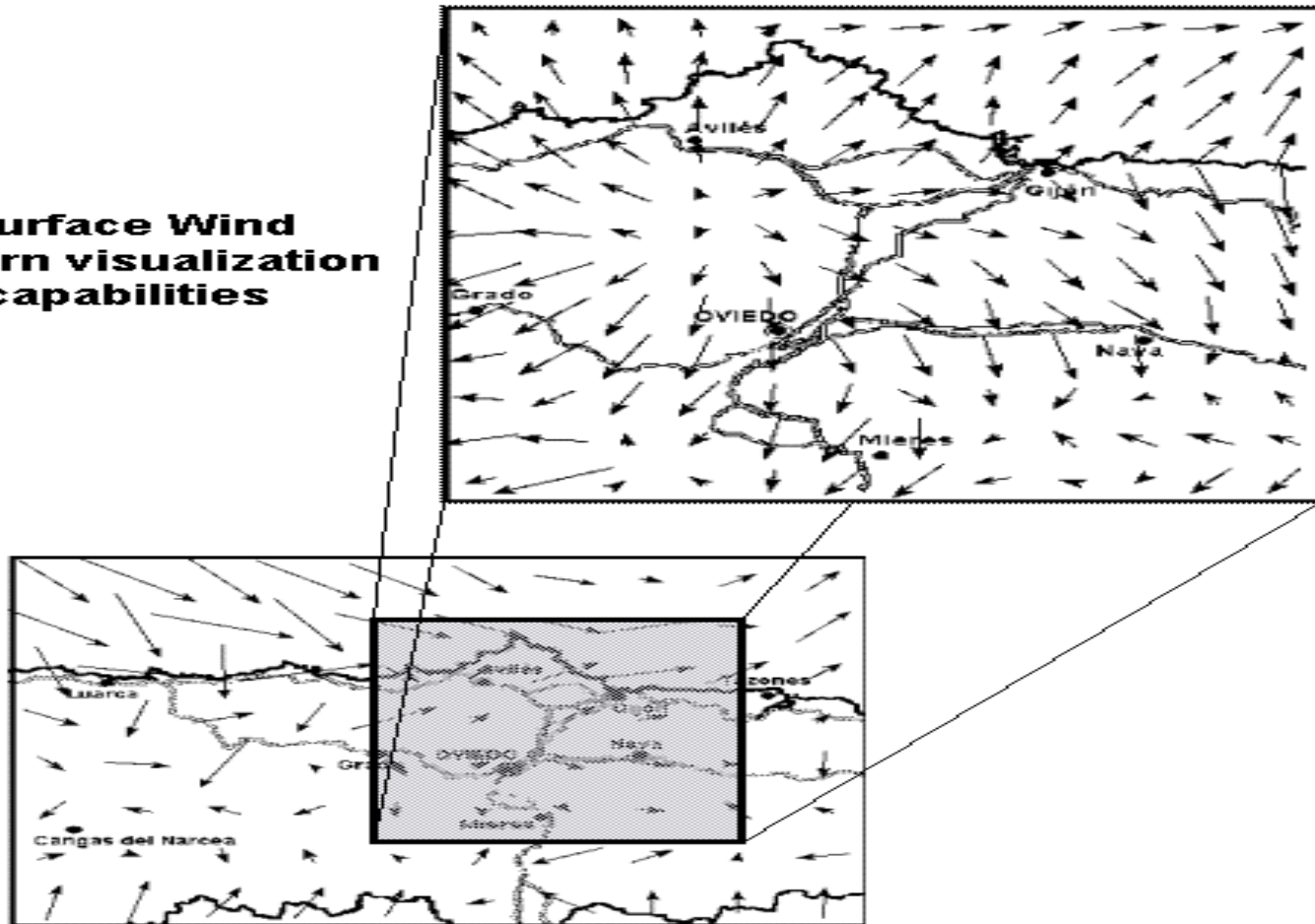
CONCENTRATION (ppb) Sulphur Dioxide (SO2) . Layer: 1



From Regional (120 x 96; 12 km)  
To Urban domain (48x48 km; 4 km).

Asturias/June, 17, 1996, 6h00.

**Surface Wind  
pattern visualization  
capabilities**

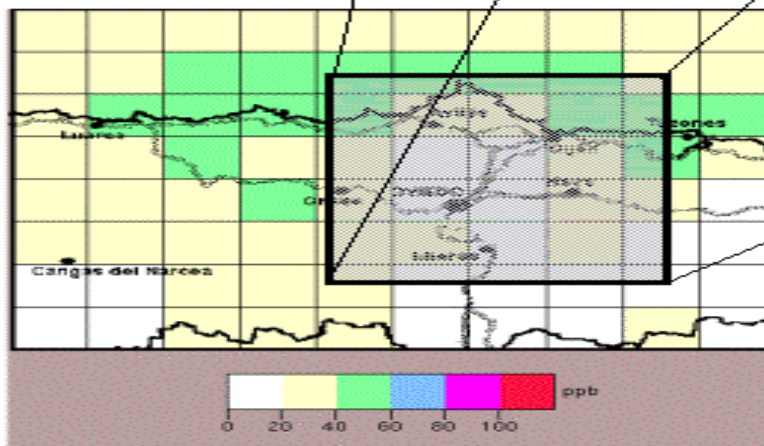
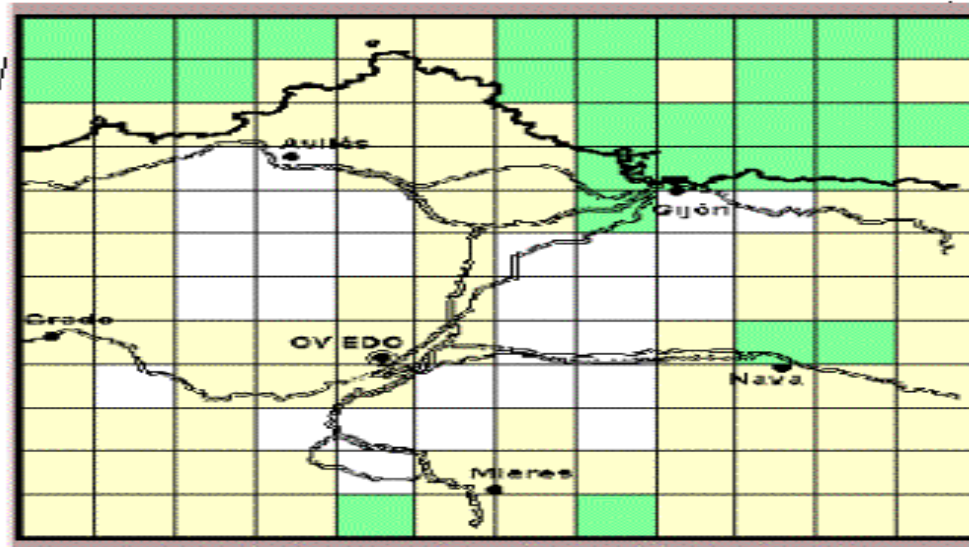




From Regional (120 x 96; 12 km)  
To Urban domain (48x48 km; 4 km).

Asturias/June, 17, 1996, 18h00.

**O3 surface  
concentration  
pattern visualization  
capabilities**



# Regional Spectral Model

Environmental Software and Modelling Group

Updated: FEB 04 2002 // Analysis: 00Z

Welcome to  
the RSM  
Home Page

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[What's New?](#)

[Users](#)

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[Web Sites](#)

[RSM Users Manual](#)

[References](#)

[Workshops](#)

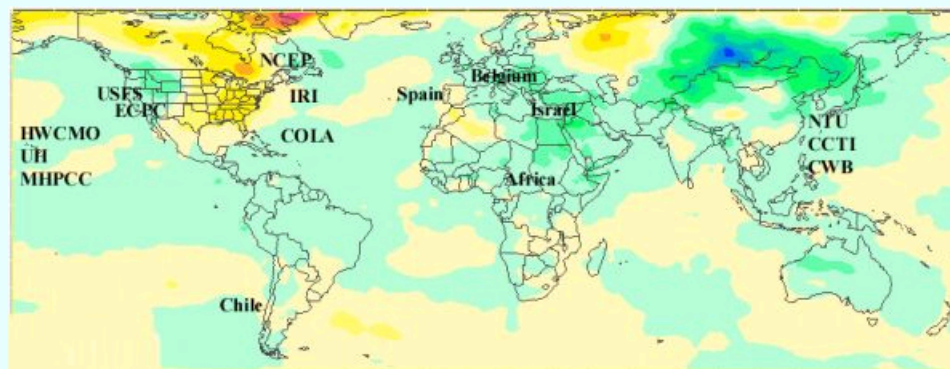
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## Regional Spectral Model



The Regional Spectral Model (RSM) was originally developed at the National Center for Environmental Predictions (NCEP) to provide regional details for the Global Spectral Model (GSM). Since the initial publications describing that work (Juang and Kanamitsu, 1994) a growing number of users have begun to use the RSM to simulate and forecast regional climate. These regional simulations and forecasts are helping the atmospheric modeling community to better connect to the application community, which needs the highest resolution possible.



# Regional Spectral Model

Environmental Software and Modelling Group

Updated: FEB 04 2002 // Analysis: 00Z

Environmental Software and Modelling Group

Computer Science School

Technical University of Madrid

Forecasts with the NOAA/NCEP Regional Spectral Model

The [NCEP Regional Spectral Model](#), developed by Hann-Ming Henry Juang, is being run at the [Environmental Software and Modelling Group](#) of the [Computer Science School](#) of the [Technical University of Madrid](#) at 27 km resolution over Spain.

Latest Environmental Software and Modelling Group RSM forecasts. Hydrostatic version

Level	Field	Analysis	06h	12h	18h	24h	30h	36h	42h	48h	54h	60h	66h	72h	78h	84h	90h	96h	102h	108h	114h	120h
Mean Sea Level	Pressure	<a href="#">00z</a>	<a href="#">06z</a>	<a href="#">12z</a>	<a href="#">18z</a>	<a href="#">24z</a>	<a href="#">30z</a>	<a href="#">36z</a>	<a href="#">42z</a>	<a href="#">48z</a>	<a href="#">54z</a>	<a href="#">60z</a>	<a href="#">66z</a>	<a href="#">72z</a>	<a href="#">78z</a>	<a href="#">84z</a>	<a href="#">90z</a>	<a href="#">96z</a>	<a href="#">102z</a>	<a href="#">108z</a>	<a href="#">114z</a>	<a href="#">120z</a>
Surface	Temperature	<a href="#">00z</a>	<a href="#">06z</a>	<a href="#">12z</a>	<a href="#">18z</a>	<a href="#">24z</a>	<a href="#">30z</a>	<a href="#">36z</a>	<a href="#">42z</a>	<a href="#">48z</a>	<a href="#">54z</a>	<a href="#">60z</a>	<a href="#">66z</a>	<a href="#">72z</a>	<a href="#">78z</a>	<a href="#">84z</a>	<a href="#">90z</a>	<a href="#">96z</a>	<a href="#">102z</a>	<a href="#">108z</a>	<a href="#">114z</a>	<a href="#">120z</a>
	Relative Humidity	<a href="#">00z</a>	<a href="#">06z</a>	<a href="#">12z</a>	<a href="#">18z</a>	<a href="#">24z</a>	<a href="#">30z</a>	<a href="#">36z</a>	<a href="#">42z</a>	<a href="#">48z</a>	<a href="#">54z</a>	<a href="#">60z</a>	<a href="#">66z</a>	<a href="#">72z</a>	<a href="#">78z</a>	<a href="#">84z</a>	<a href="#">90z</a>	<a href="#">96z</a>	<a href="#">102z</a>	<a href="#">108z</a>	<a href="#">114z</a>	<a href="#">120z</a>
	Accumulated Precipitation	-	<a href="#">06z</a>	<a href="#">12z</a>	<a href="#">18z</a>	<a href="#">24z</a>	<a href="#">30z</a>	<a href="#">36z</a>	<a href="#">42z</a>	<a href="#">48z</a>	<a href="#">54z</a>	<a href="#">60z</a>	<a href="#">66z</a>	<a href="#">72z</a>	<a href="#">78z</a>	<a href="#">84z</a>	<a href="#">90z</a>	<a href="#">96z</a>	<a href="#">102z</a>	<a href="#">108z</a>	<a href="#">114z</a>	<a href="#">120z</a>
	Total Cloud Cover	-	<a href="#">06z</a>	<a href="#">12z</a>	<a href="#">18z</a>	<a href="#">24z</a>	<a href="#">30z</a>	<a href="#">36z</a>	<a href="#">42z</a>	<a href="#">48z</a>	<a href="#">54z</a>	<a href="#">60z</a>	<a href="#">66z</a>	<a href="#">72z</a>	<a href="#">78z</a>	<a href="#">84z</a>	<a href="#">90z</a>	<a href="#">96z</a>	<a href="#">102z</a>	<a href="#">108z</a>	<a href="#">114z</a>	<a href="#">120z</a>
	Wind Field	<a href="#">00z</a>	<a href="#">06z</a>	<a href="#">12z</a>	<a href="#">18z</a>	<a href="#">24z</a>	<a href="#">30z</a>	<a href="#">36z</a>	<a href="#">42z</a>	<a href="#">48z</a>	<a href="#">54z</a>	<a href="#">60z</a>	<a href="#">66z</a>	<a href="#">72z</a>	<a href="#">78z</a>	<a href="#">84z</a>	<a href="#">90z</a>	<a href="#">96z</a>	<a href="#">102z</a>	<a href="#">108z</a>	<a href="#">114z</a>	<a href="#">120z</a>
850 mb	Temperature	<a href="#">00z</a>	<a href="#">06z</a>	<a href="#">12z</a>	<a href="#">18z</a>	<a href="#">24z</a>	<a href="#">30z</a>	<a href="#">36z</a>	<a href="#">42z</a>	<a href="#">48z</a>	<a href="#">54z</a>	<a href="#">60z</a>	<a href="#">66z</a>	<a href="#">72z</a>	<a href="#">78z</a>	<a href="#">84z</a>	<a href="#">90z</a>	<a href="#">96z</a>	<a href="#">102z</a>	<a href="#">108z</a>	<a href="#">114z</a>	<a href="#">120z</a>
	Relative Humidity	<a href="#">00z</a>	<a href="#">06z</a>	<a href="#">12z</a>	<a href="#">18z</a>	<a href="#">24z</a>	<a href="#">30z</a>	<a href="#">36z</a>	<a href="#">42z</a>	<a href="#">48z</a>	<a href="#">54z</a>	<a href="#">60z</a>	<a href="#">66z</a>	<a href="#">72z</a>	<a href="#">78z</a>	<a href="#">84z</a>	<a href="#">90z</a>	<a href="#">96z</a>	<a href="#">102z</a>	<a href="#">108z</a>	<a href="#">114z</a>	<a href="#">120z</a>
	Absolute Vorticity	<a href="#">00z</a>	<a href="#">06z</a>	<a href="#">12z</a>	<a href="#">18z</a>	<a href="#">24z</a>	<a href="#">30z</a>	<a href="#">36z</a>	<a href="#">42z</a>	<a href="#">48z</a>	<a href="#">54z</a>	<a href="#">60z</a>	<a href="#">66z</a>	<a href="#">72z</a>	<a href="#">78z</a>	<a href="#">84z</a>	<a href="#">90z</a>	<a href="#">96z</a>	<a href="#">102z</a>	<a href="#">108z</a>	<a href="#">114z</a>	<a href="#">120z</a>
	Geopotential Height	<a href="#">00z</a>	<a href="#">06z</a>	<a href="#">12z</a>	<a href="#">18z</a>	<a href="#">24z</a>	<a href="#">30z</a>	<a href="#">36z</a>	<a href="#">42z</a>	<a href="#">48z</a>	<a href="#">54z</a>	<a href="#">60z</a>	<a href="#">66z</a>	<a href="#">72z</a>	<a href="#">78z</a>	<a href="#">84z</a>	<a href="#">90z</a>	<a href="#">96z</a>	<a href="#">102z</a>	<a href="#">108z</a>	<a href="#">114z</a>	<a href="#">120z</a>



# Regional Spectral Model

Environmental Software and Modelling Group  
Updated: FEB 04 2002 // Analysis: 00Z

Day: 2  
Time: 12 H  
Frame: 060 H

Image Control

< >

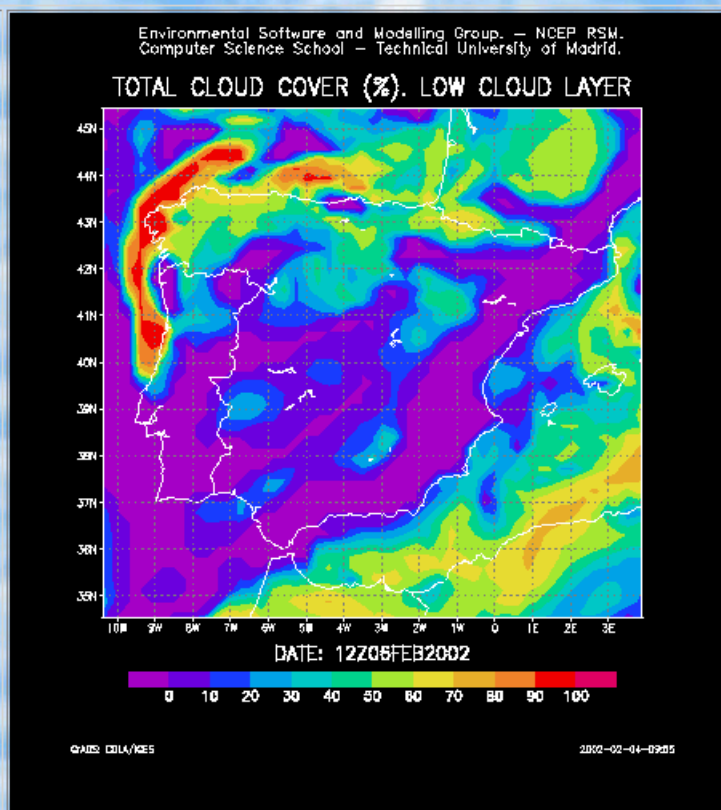
<< >>

Animation Control

Start Stop

Main Menu

Main Page



# Regional Spectral Model

Environmental Software and Modelling Group  
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## Environmental Software and Modelling Group Computer Science School Technical University of Madrid Forecasts with the NOAA/NCEP Regional Spectral Model

The [NCEP Regional Spectral Model](#), developed by Hann-Ming Henry Juang, is being run at the [Environmental Software and Modelling Group](#) of the [Computer Science School](#) of the [Technical University of Madrid](#) at 27 km resolution over Spain.

**Meteogram location:**  
Latitude: 40.37°N ; Longitude:

**Select a meteogram parameter:**

Surface Temperature - 2 meter	and Modelling Group RSM forecasts.
Relative Humidity - 2 meter	atic version
Specific Humidity - 2 meter	
Wind Speed - 10 meter	
Zonal Wind - 10 meter	
Meridional Wind - 10 meter	
3 Hours Accumulated Precipitation	
Mean Sea Level Pressure	
Ground Surface Pressure	
Ground Surface Temperature	location.
Ground Surface Geopotential Height	

User defined parameters to plot:

Forecast duration from starting time [hours]:

Once you press the request button, be patient while the plot is drawn.



MM5 Forecast Model Graphics - Netscape

File Edit View Go Communicator Help

Back Forward Reload Home Search Netscape Print Security Shop Stop

Bookmarks Location: <http://atmosfera.lma.fi.upm.es/mm5/> What's Related

RealPlayer

**Environmental Software and Modelling Group**  
**Updated: Aug 18 2001 // Analysis: 00**

**36 M. TEMPERATURE ( C) - MM5**

Zoom In  
 Zoom Out  
 Scroll  
 Query

Main Menu  
 Main Page

DATE: 12Z22AUG2001

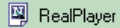
16 20 22 24 26 28 30 32 34

0405 0014/055 2001-08-19-11:05

Document: Done

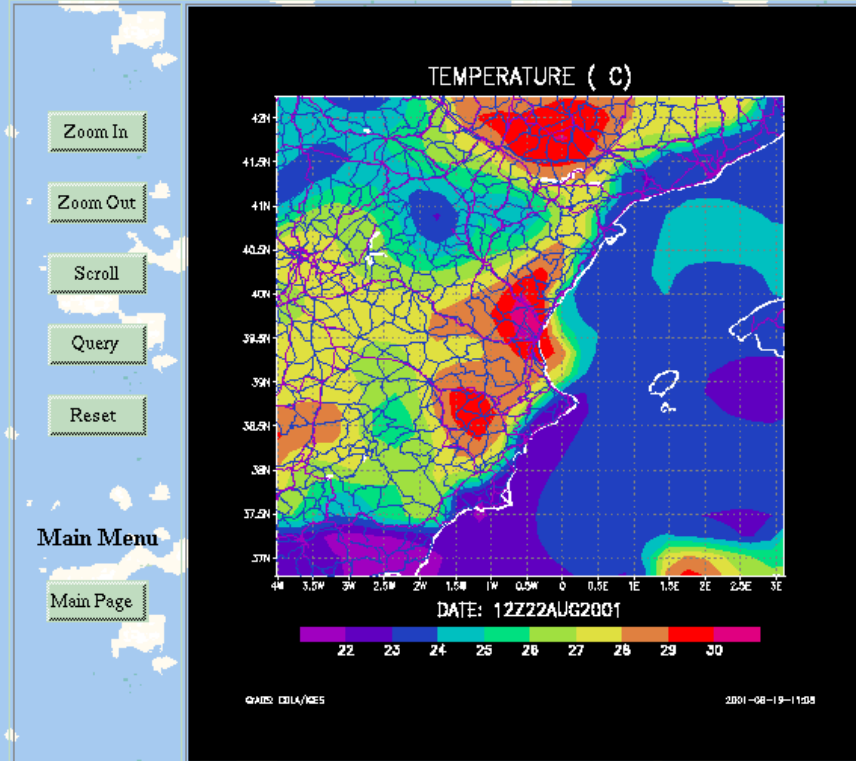
Inicio F... N... E... R... P... A... P... P... P... C... R... P... o... M... ES 11:01





### Environmental Software and Modelling Group

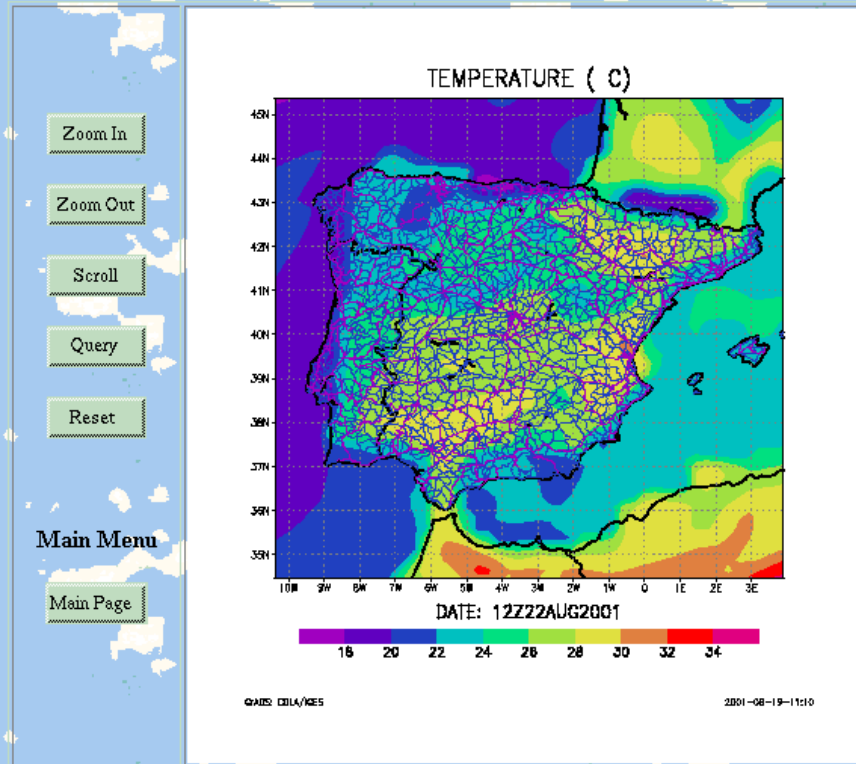
Updated: Aug 18 2001 // Analysis: 00



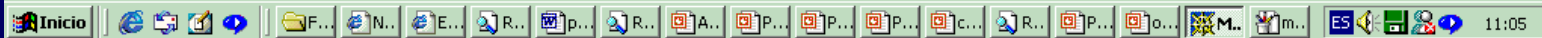


### Environmental Software and Modelling Group

Updated: Aug 18 2001 // Analysis: 00



Document: Done





**MM5 Forecast Model Graphics - Netscape**

File Edit View Go Communicator Help

Back Forward Reload Home Search Netscape Print Security Shop Stop

Location: <http://atmosfera.lma.fi.upm.es/mm5/> What's Related

RealPlayer

**Environmental Software and Modelling Group**  
**Updated: Aug 18 2001 // Analysis: 00**

TEMPERATURE ( C)

Zoom In  
 Zoom Out  
 Scroll  
 Query  
 Reset

Main Menu  
 Main Page

DATE: 12Z22AUG2001

©2001 OLA/RES 2001-08-19-11:12

Document: Done

Inicio F... N... E... R... p... A... P... P... P... C... R... P... o... M... m... ES 11:06



MMS Forecast Model Graphics - Netscape

File Edit View Go Communicator Help

Back Forward Reload Home Search Netscape Print Security Shop Stop

Location: <http://atmosfera.lma.fi.upm.es/fire/>

RealPlayer

### FIRE WEATHER FORECAST

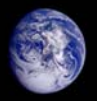
Environmental Software and Modelling Group  
 Computer Science School - Technical University of Madrid  
 15Z20AUG2001

Updated: Aug 18 2001

[RETURN](#)

Document: Done

Inicio | [Icons] | 11:08

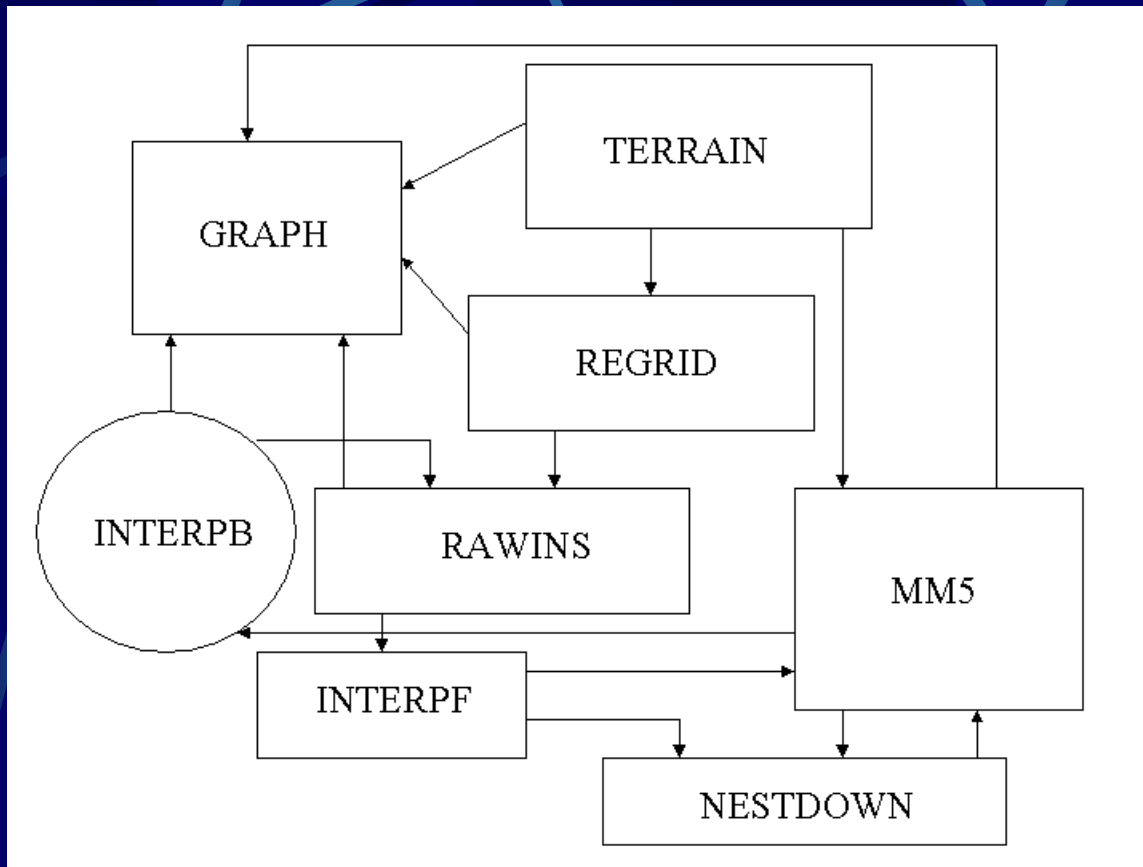


**Environmental Software and Modelling Group**  
<http://artico.lma.fi.upm.es>



**upm**  
 UNIVERSIDAD POLITÉCNICA DE MADRID

# THE MM5-CMAQ MODELLING SYSTEM



## THE MM5 MODEL



# MM5

**Meteorological Forecasts with PSU/NCAR Mesoscale Modeling System (MM5 Version 3) over Iberian Peninsula**  
Environmental Software and Modelling Group Updated: Oct 18 2002 // Analysis: 0

Select user options, press the request button, select an option on the right area and click on the map. Other available displays are:

[METEGRAMS](#) OR [SOUNDIGS](#)

**USER OPTIONS**

**Meteorological Fields:**  
Temperature

**Time [hours]:** 3:00 H 18 Oct

**Vertical level:** 36 Meters Aprox.(AGL)

**GIS OPTIONS**  
Graphic Type: Shaded

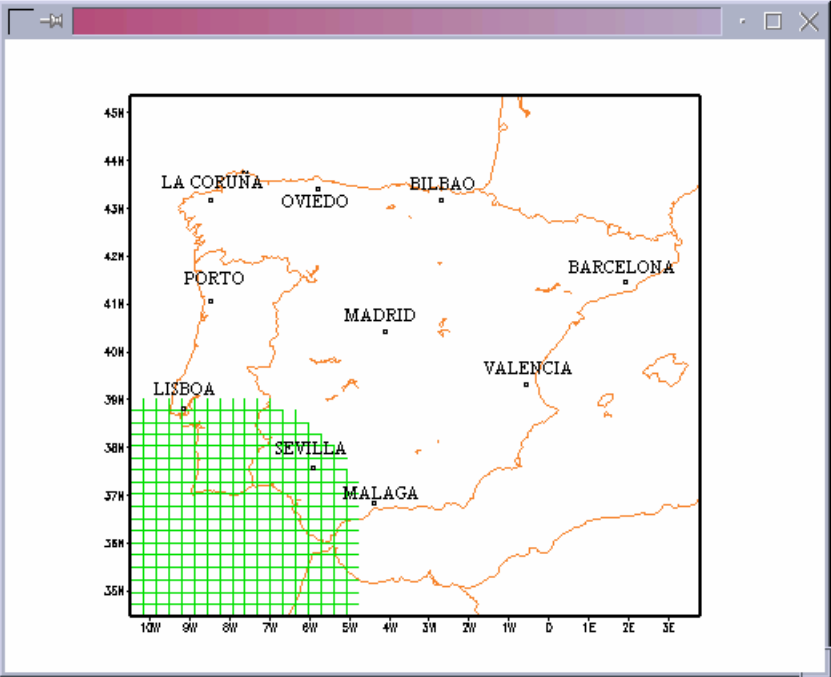
**Layers:**

- Road lines
- Railroad lines
- White Background Color
- Political Boundaries:  
Boundary line color: White  
Boundary thickness: 1

Request Data Pattern

Once you press the request button, be patient while the plot

**Map Controls:**  
ZOOM-IN  
ZOOM-OUT  
PAN  
QUERY  
HOME



Map navigation buttons: Home, Previous, Next, Stop



# MM5

Meteorological Forecasts with PSU/NCAR Mesoscale Modeling System (MM5 Version 3.5.2) Environmental Software and Modelling Group Updated: Oct 18 2002 // A

Select user options, press the request button, select an option on the right area and click on the map. Other available displays are:

[METEGRAMS](#) OR [SOUNDINGS](#)

**USER OPTIONS**

**Meteorological Fields:**  
 Accumulated precipitation ▾

**Time [hours]:** 21:00 H 22 Oct ▾

**Vertical level:** 36 Meters Aprox.(AGL) ▾

**GIS OPTIONS**  
 Graphic Type: Shaded ▾

**Layers:**

- Road lines
- Railroad lines
- White Background Color
- Political Boundaries:
  - Boundary line color: White ▾
  - Boundary thickness: 1 ▾

Request Data Pattern

Once you press the request button, be patient while the plot

ZOOM-IN  
 ZOOM-OUT  
 PAN  
 QUERY  
 HOME

ACCUMULATED P  
DATE: 21Z22OCT2002

0 0.2 0.4 0.8 0.8 1 1.2 1.4 1.6 1.8 2 2.2

DATE: 21Z22OCT2002

0 0.2 0.4 0.8 0.8 1 1.2 1.4 1.6 1.8 2 2.2

DATE: 21Z22OCT2002

TEMPERATURE (C)

ANIMATION

# MM5: MCIP

## Meteorological Forecasts with PSU/NCAR Mesoscale Modeling System (MM5 Version 3) over Iberian Peninsula (NEW!)

Environmental Software and Modelling Group Updated: Oct 19 2002 // Analysis: 0

Once you press the button, please be patient while the plot is drawn.

### USER OPTIONS

#### Surface Meteorological Fields:

- Deposition velocity for species HCHO
- Surface pressure
  - Total Jacobian at surface
  - Air density at surface
  - Cell averaged friction velocity
  - Convective velocity scale
  - PBL height
  - Surface roughness length
  - Inverse of Monin-Obukhov length
  - Sensible heat flux
  - Latent heat flux
  - Inverse of aerodynamic resistance

Railroads  Political Boundaries:

Boundary line color: White

Boundary thickness: 1

Request Data Pattern

Once you press the button, please be patient while the plot is drawn.

ZOOM-IN

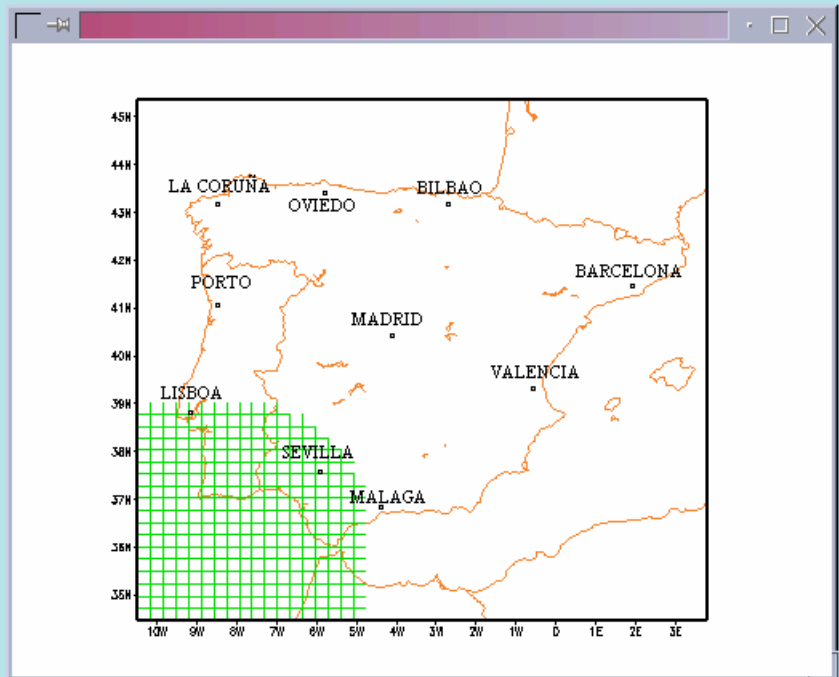
ZOOM-OUT

PAN

QUERY

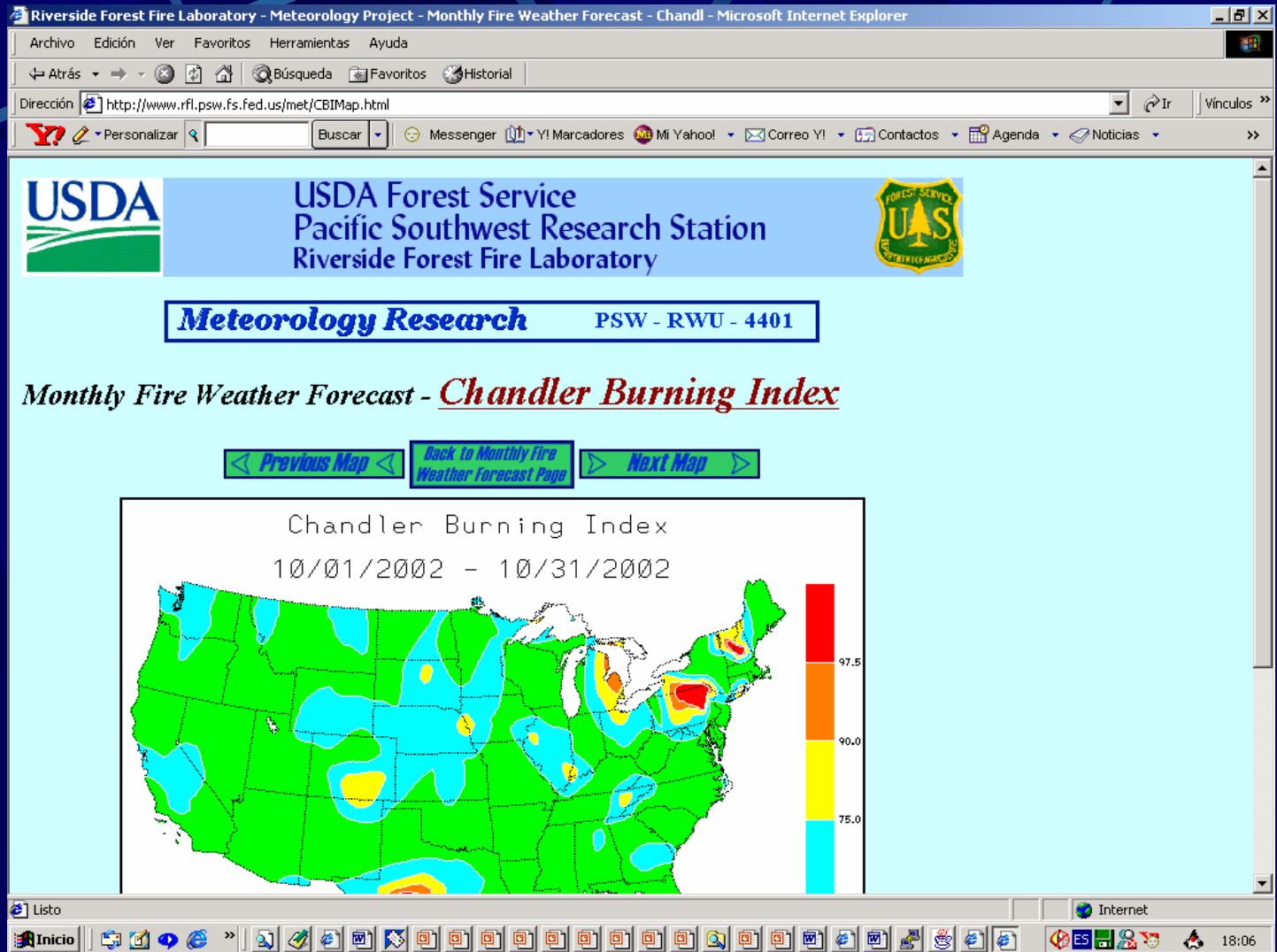


HOME



# Chandler Burning Index

<http://www.rfl.psw.fs.fed.us/met/CBIMap.html>



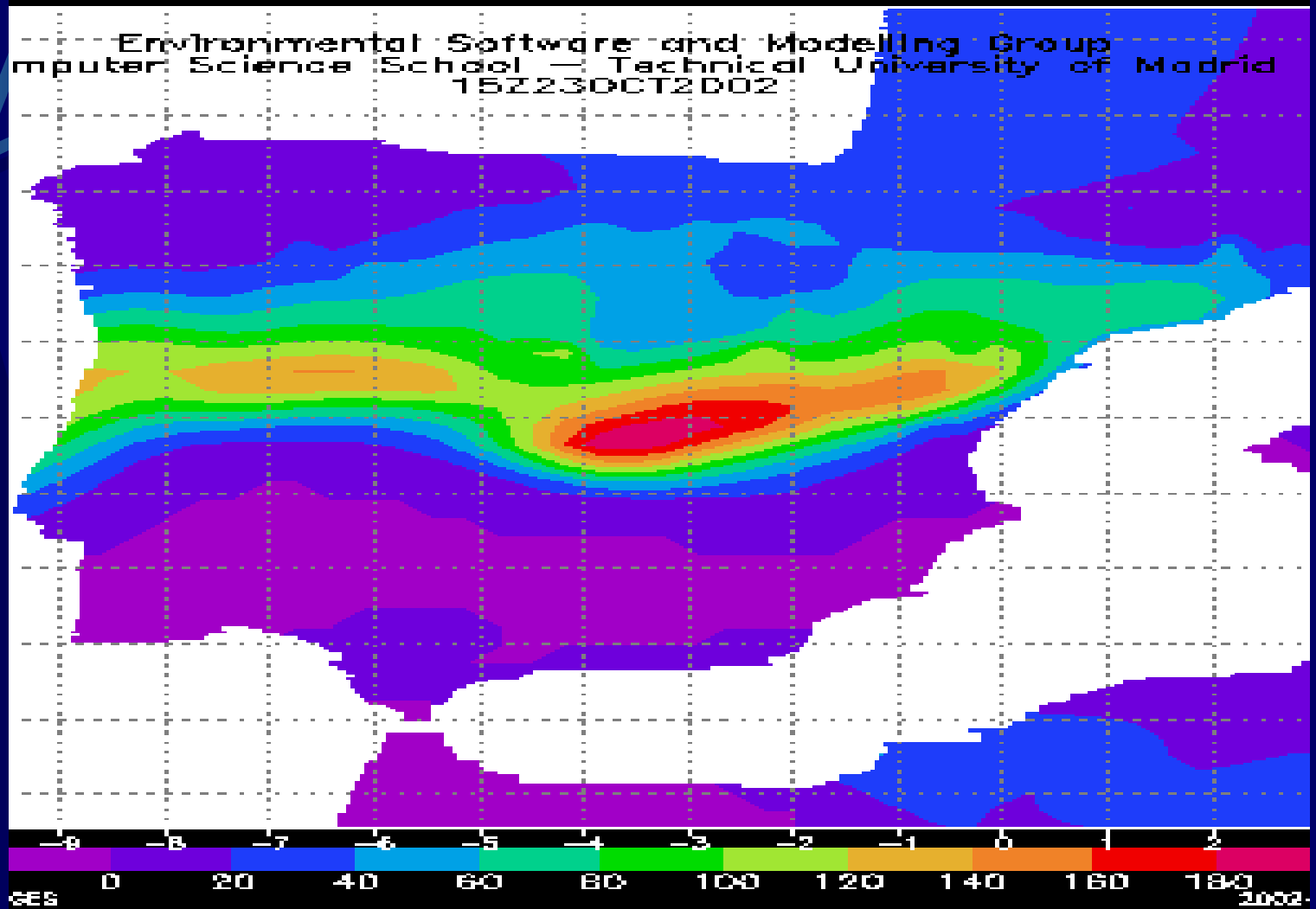
Environmental Software and Modelling  
Group <http://artico.lma.fi.upm.es>



**upm**

UNIVERSIDAD POLITÉCNICA DE MADRID

# Chandler Burning Index

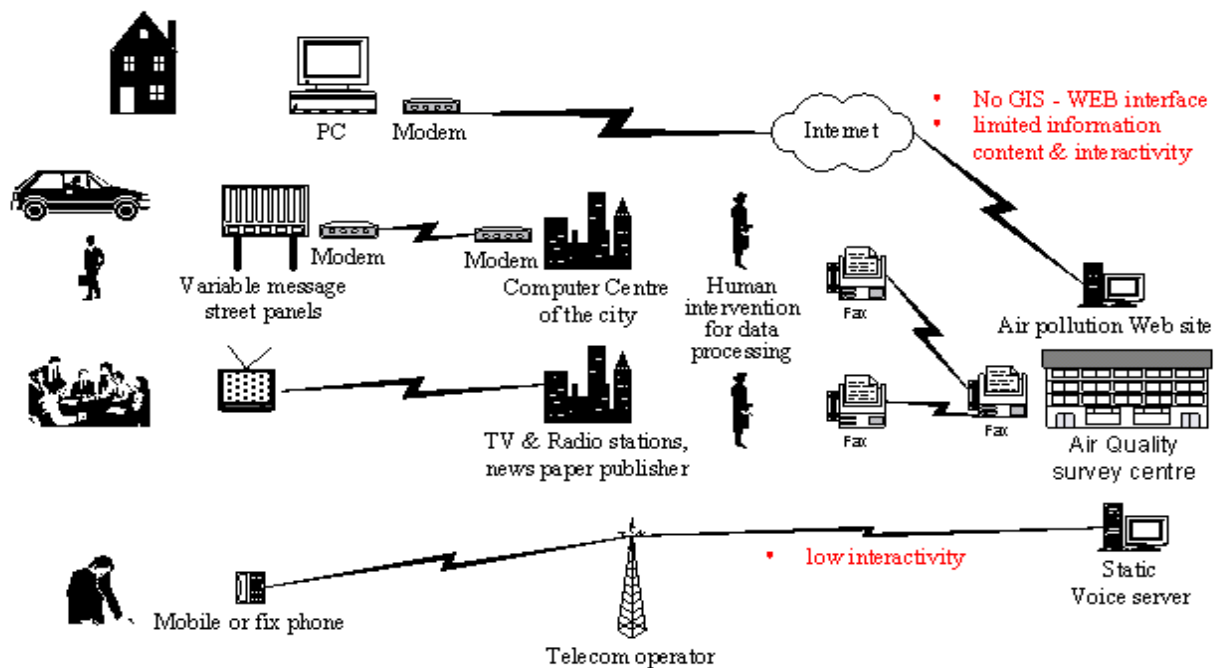




Providing multi-modal access to environmental data  
Customisable information services for disseminating urban air quality  
information in APNEE



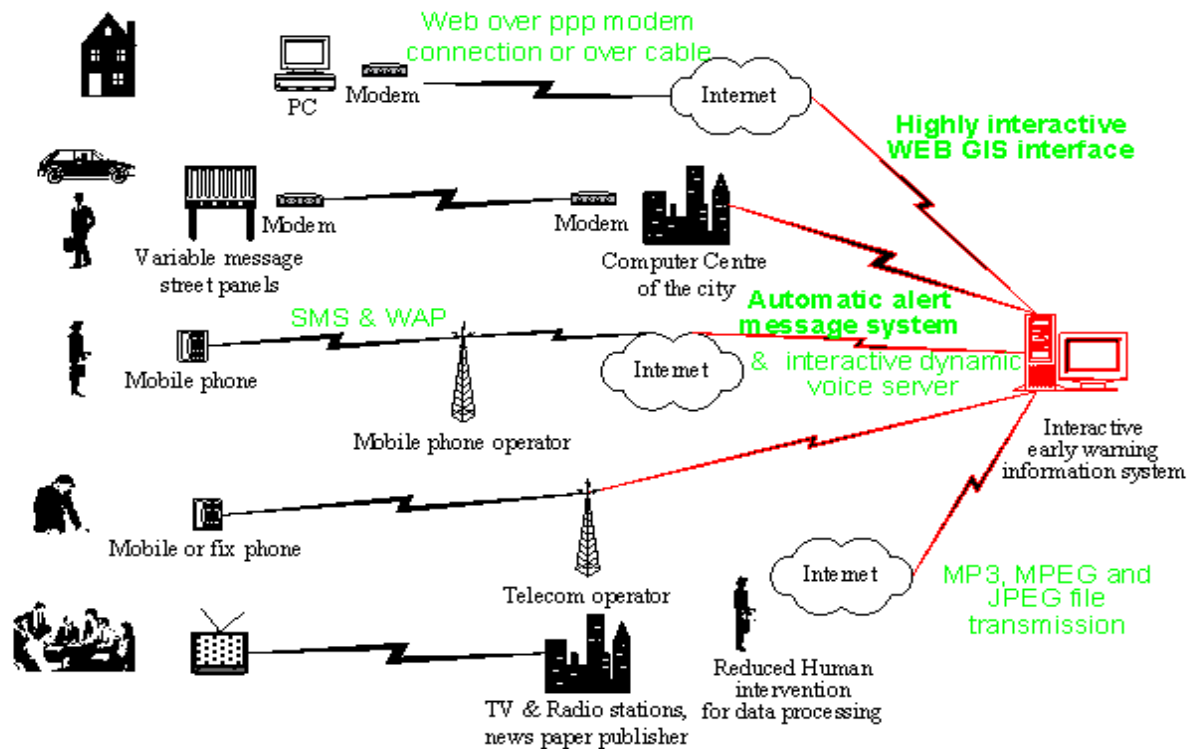
## Before APNEE



**Providing multi-modal access to environmental data**  
 Customisable information services for disseminating urban air quality information in APNEE



# After APNEE



## APNEE: Air Pollution Network for Early warning and on-line information Exchange in Europe



The APNEE project aims at increasing the knowledge of citizens on air quality, at developing exchange of information both on local level in European cities and among European institutions. The information of air quality will take place by implementing new communication lines like mobile telephone functionality, multimedia, electronic panels and Internet. The APNEE project will integrate new information technology as additional management modules in existing Air Quality Management Systems in European cities.

[REGIONAL SERVER FOR MADRID](#)

Further information on APNEE can be obtained [here](#).



# APNEE EU – IST PROJECT 2000-01

APNEE Air pollution network for early warning and online information in Europe

## APNEE REGIONAL SERVER

- Home
- Monitoring data: yesterday
- Forecasting
- Pollutants
- Subscription

Admin  
Log

Subscription

Step 2/2

Your region is

**Personal information**

Identifier:

Password:

First name:

Last name:

Profession:

Age:

Gender:  Male  Female

**Contact information**

Address:

Email:


Phone:

Mobile phone (Ej 666443322):


**Email information**  
Please select if you would like to receive pollution bulletin via email.



Forecasting  
Pollutants  
Subscription

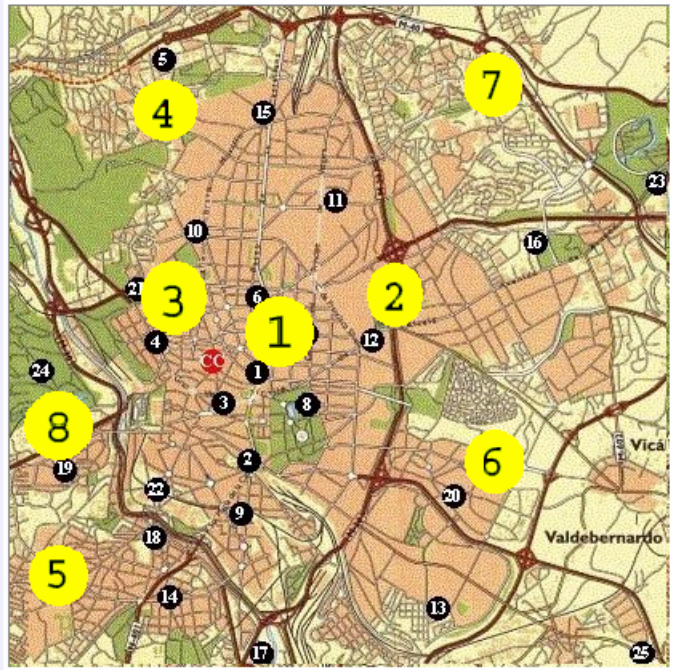


**MADRID MUNICIPALITY AIR QUALITY INDEX: FORECASTING MODE** (OPANA MODEL)



Admin  
Login

DAY 07-10-02



SCALE	AREA	DOMINANT POLLUTANT	VALUE *
	1	NO2	52
	2	NO2	54
	3	NO2	53
	4	NO2	52
	5	NO2	54
	6	NO2	54
	7	NO2	54
	8	NO2	56

150	100	50	0		
					Muy malo
					Malo
					Admisible
					Bueno

Environmental Software and Modelling Group <http://artico.lma.fi.upm.es>

**upm**  
UNIVERSIDAD POLITÉCNICA DE MADRID

## WEB/GIS (I)

Swing Applet - Microsoft Internet Explorer

WebGISApplet

S.I.G. PARA LA CALIDAD DEL AIRE (APNEE)

Click over the pollution panel you wish

O3 (PPB)  
0 30 61 92

SO2 (PPB)  
0 23 47 71

NO2 (PPB)  
0 53 106 159

NO (PPB)  
0 81 163 244

CO (PPB)  
0 4000 9000 13000

FACHADAS

ACERAS

Subprograma iniciado

Inicio

17:52



# APNEE EU – IST PROJECT 2000-01

## WEB/GIS (II)

S.I.G. PARA LA CALIDAD DEL AIRE (APNEE)

Click over the pollution panel you wish

O3 (PPB)  
0 30 61 92

SO2 (PPB)  
0 23 47 71

NO2 (PPB) 10-07-2002 20:00 GMT  
0 53 106 159

NO (PPB)  
0 81 163 244

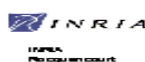
CO (PPB)  
0 4000 9000 13000

CONCENTRATION (ppb) Nitrogen Dioxide (NO2), 10/18/2002, Layer: 1

220  
200  
180  
160  
140  
120



# DECAIR EU PROJECT: CEO (CENTRE FOR EARTH OBSERVATION) 2000-02



## DECAIR

Development of an Earth Observation data converter with application to air quality forecast

## Objectives

The major objectives of DECAIR are to provide data, extracted from satellite images, for an air quality simulation models:

- to enhance the quality of results;
- to ease the implementation of models to new sites

## Challenges

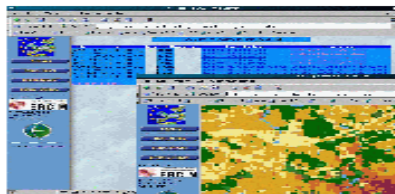
To define an architecture and to implement a prototype supporting the required functionalities to fulfil these objectives

## DECAIR PROTOTYPE DEMONSTRATOR:

A user interface, that allows users to ...

1

Query the database:  
Models inputs  
Land use maps  
DEMs  
Land use legends  
Preview and download query results



Generate data from satellite imagery

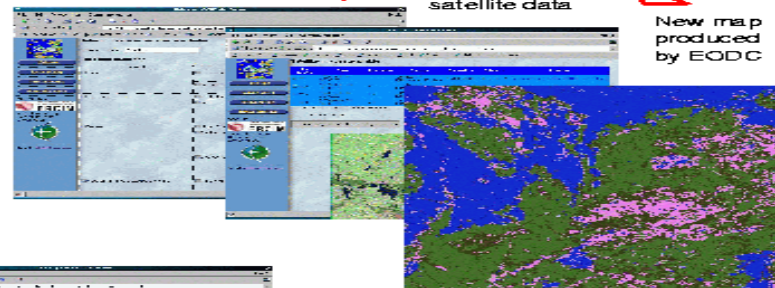
2

land use  
Cloud cover  
Solar irradiation

definition of classes

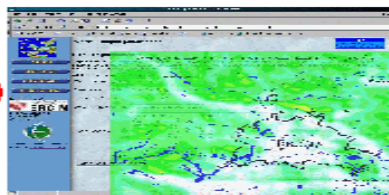
browsing satellite data

New map produced by EODC



3

Publish the simulation results obtained using DECAIR data



## CONTACT

Co-ordination: ER CIM  
Bruno.Le\_Dantec@ercim.org  
Scientific co-ordination: INRIA  
decair-coordination@air-mail.inria.fr





# **OSCAR: OPTIMISED EXPERT SYSTEM FOR CONDUCTING ENVIRONMENTAL ASSESSMENT OF URBAN ROAD TRAFFIC (2002-2005)**

- (1) University of Hertfordshire (“The Coordinator”)**
- (2) Westminster City Council**
- (3) TRL Ltd**
- (4) Finnish Meteorological Institute (FMI)**
- (5) Helsinki Metropolitan Area Council (YTV)**
- (6) Norwegian Institute for Air Research (NILU)**
- (7) Municipality of Oslo Department of Public Health (ODPH)**
- (8) National Centre for Scientific Research ‘Demokritos’ (NCSR)**
- (9) Universidad Politecnica de Madrid (UPM)**
- (10) Sociedad Iberica de Construcciones Electricas S A (SICE)**
- (11) Netherlands Organisation for Applied Scientific Research (TNO)**
- (12) City of Utrecht**





## DECAIR

Development of an Earth Observation data converter with application to air quality forecast

### Objectives

The major objectives of DECAIR are to provide data, extracted from satellite images, for air quality simulation models:

- to enhance the quality of results;
- to ease the implementation of models to new sites

### Challenges

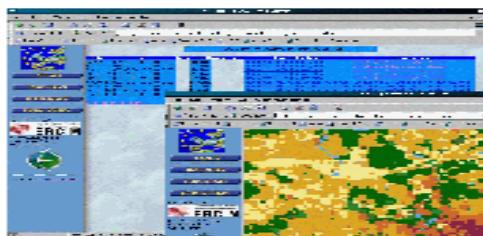
To define an architecture and to implement a prototype supporting the required functionalities to fulfil these objectives

### DECAIR PROTOTYPE DEMONSTRATOR:

A user interface, that allows users to ...

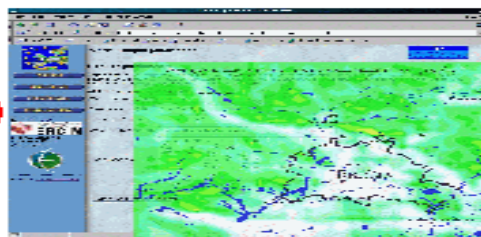
1

Query the database:  
 Models inputs  
 Land use maps  
 DEMs  
 Land use legends  
 Preview and download query results



3

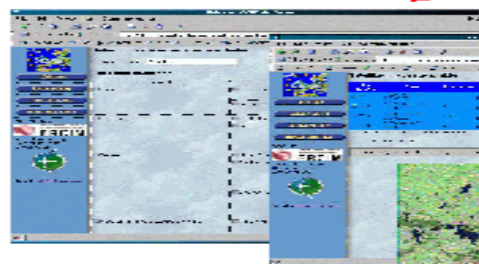
Publish the simulation results obtained using DECAIR data



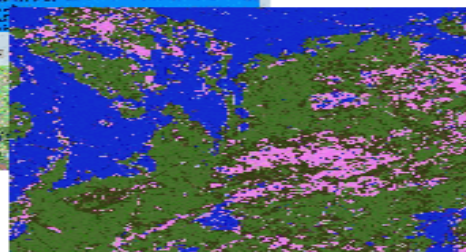
2 Generate data from satellite imagery

land use  
 Cloud cover  
 Solar irradiation

definition of classes



browsing satellite data



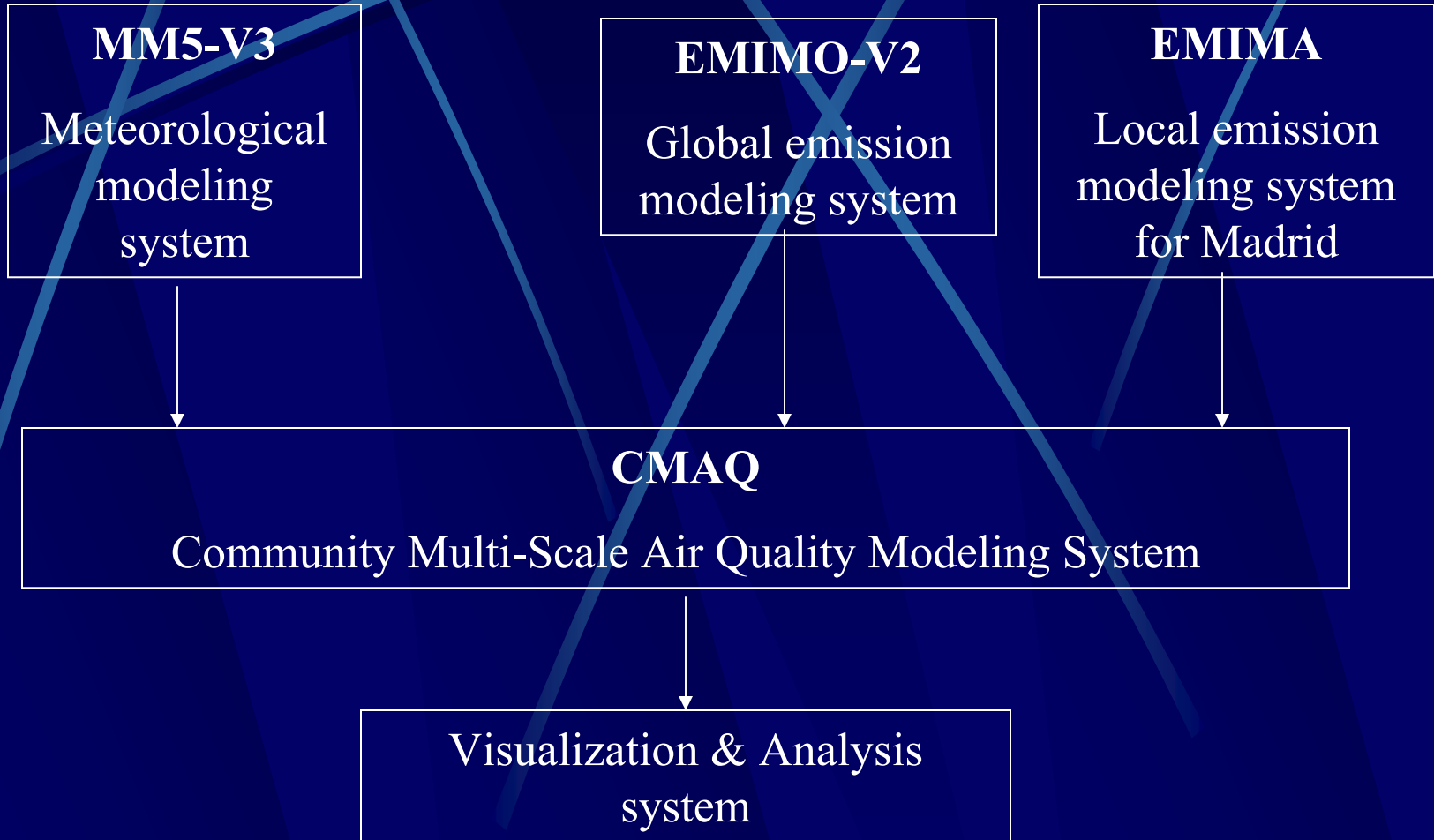
New map produced by EODC

### CONTACT

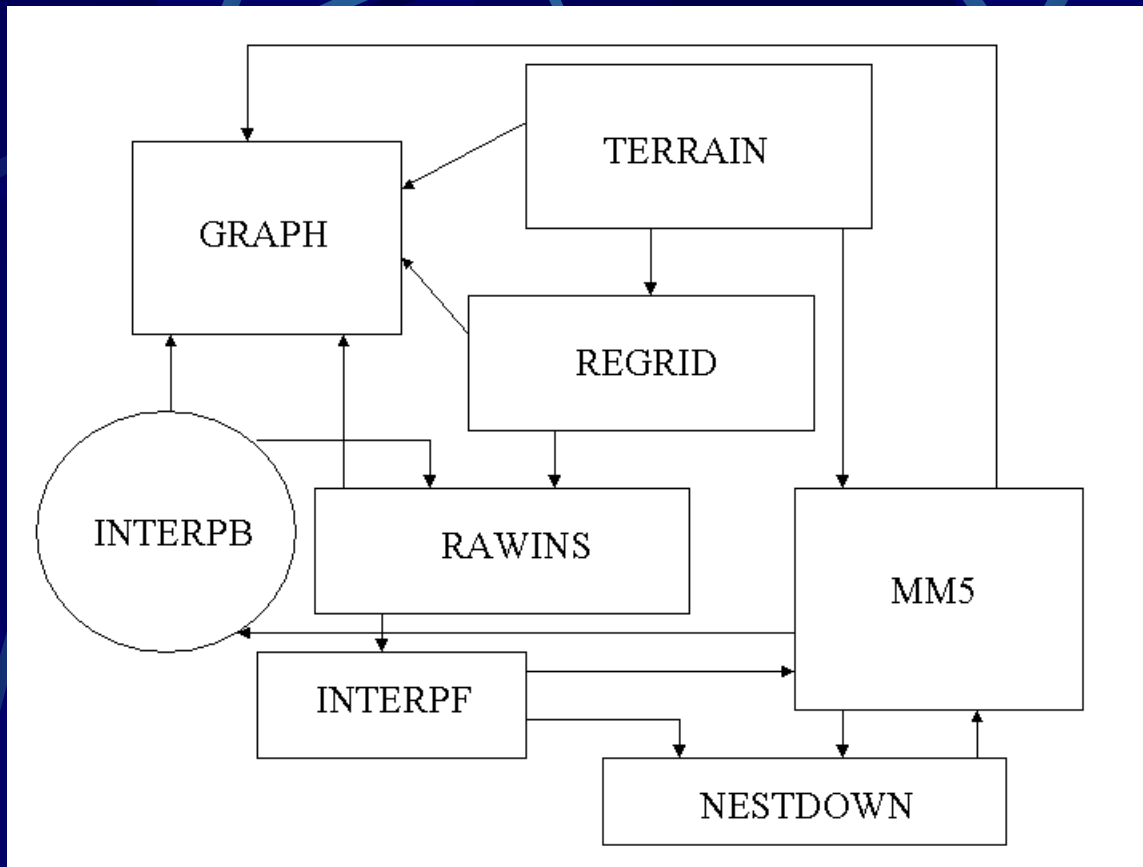
Co-ordination: ERCIM  
 Bruno.Le\_Dantec@ercim.org  
 Scientific co-ordination: INRIA  
 decair-coordination@air-mail.inria.fr



# MM5-CMAQ MODELLING SYSTEM



# THE MM5-CMAQ MODELLING SYSTEM



## THE MM5 MODEL

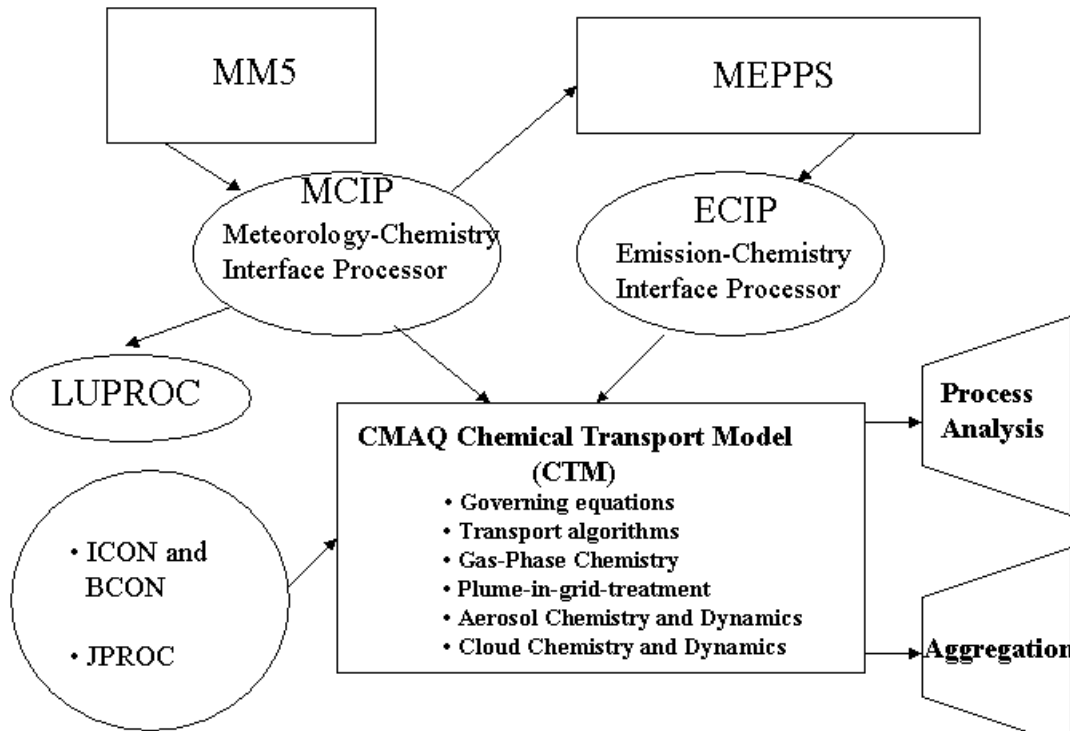


# THE MM5-CMAQ MODELLING SYSTEM

# Models 3

EPA's Third Generation  
Air Quality Modeling System

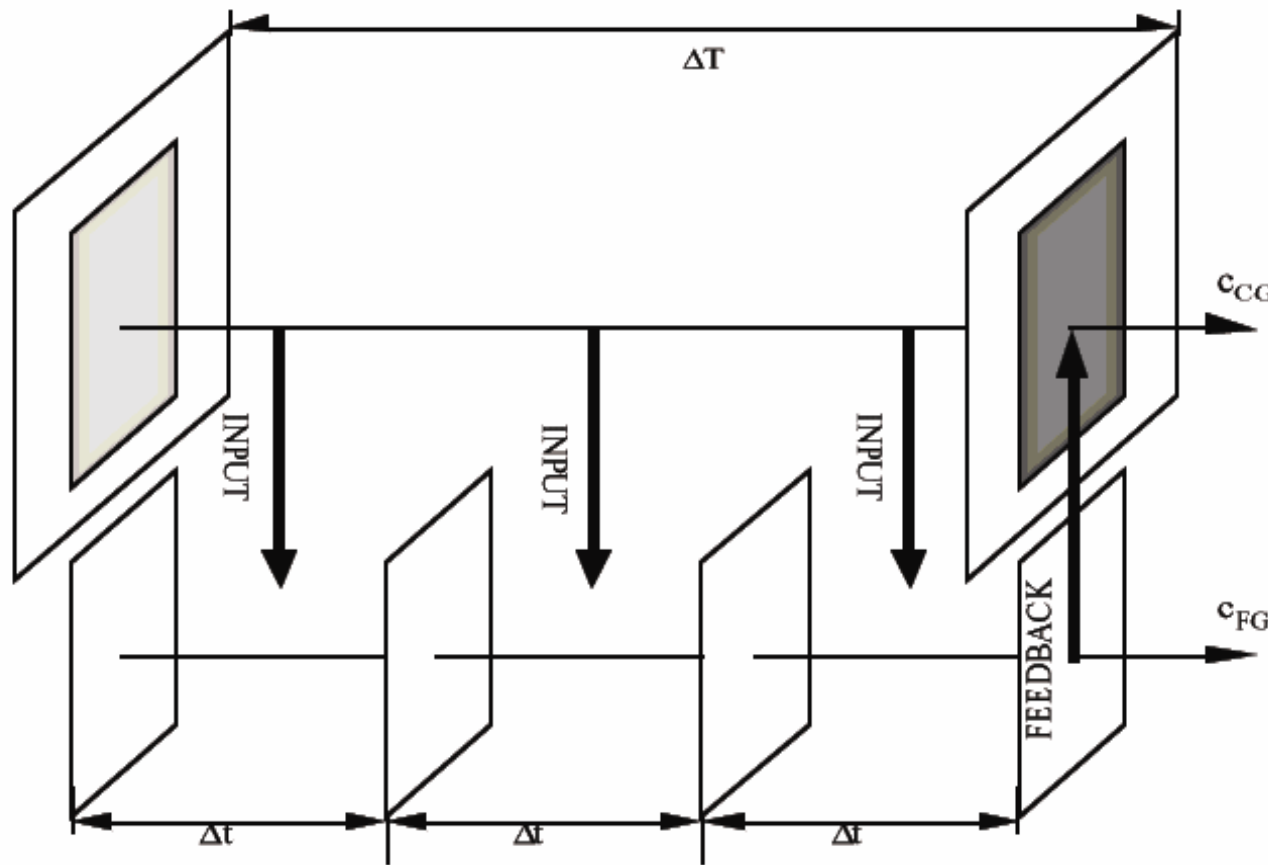
## EMISSIONS, METEOROLOGICAL MODELLING AND CMAQ SYSTEMS



# THE CMAQ MODEL



# THE CMAQ MODELLING SYSTEM: NESTING APPROACH



The static Nesting Approach in CMAQ

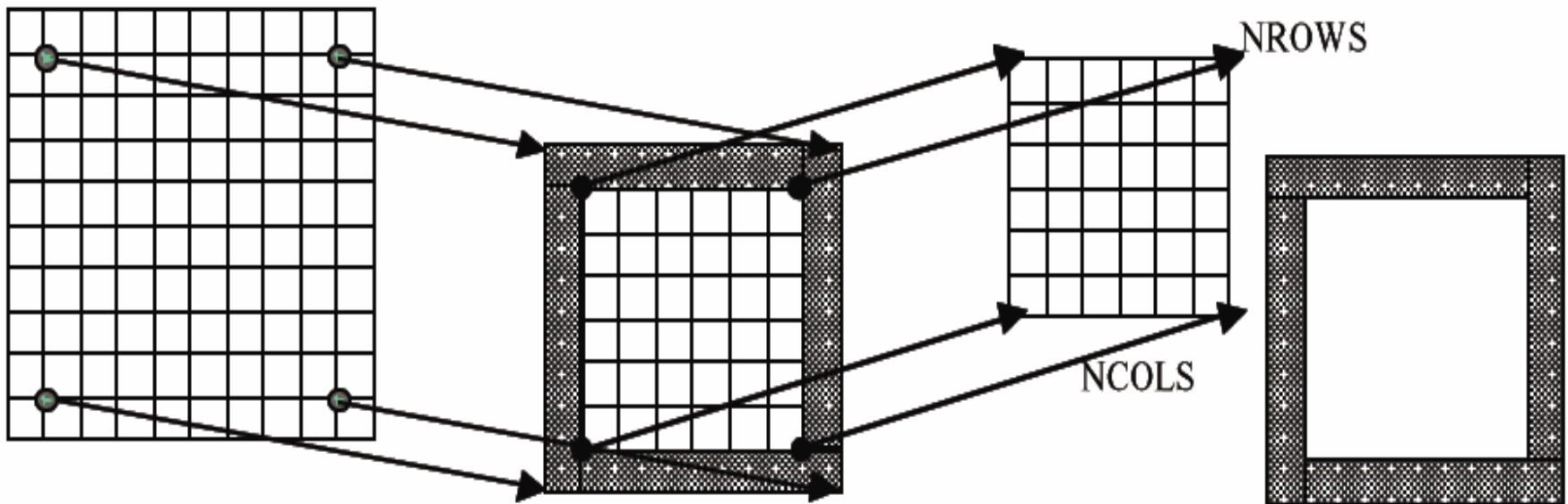


# THE CMAQ MODELLING SYSTEM: MM5-CMAQ LINKING

Input phase

Processing

Output phase



Met. Domain  
'F'-arrays

Extended CMAQ Domain  
'X'-arrays

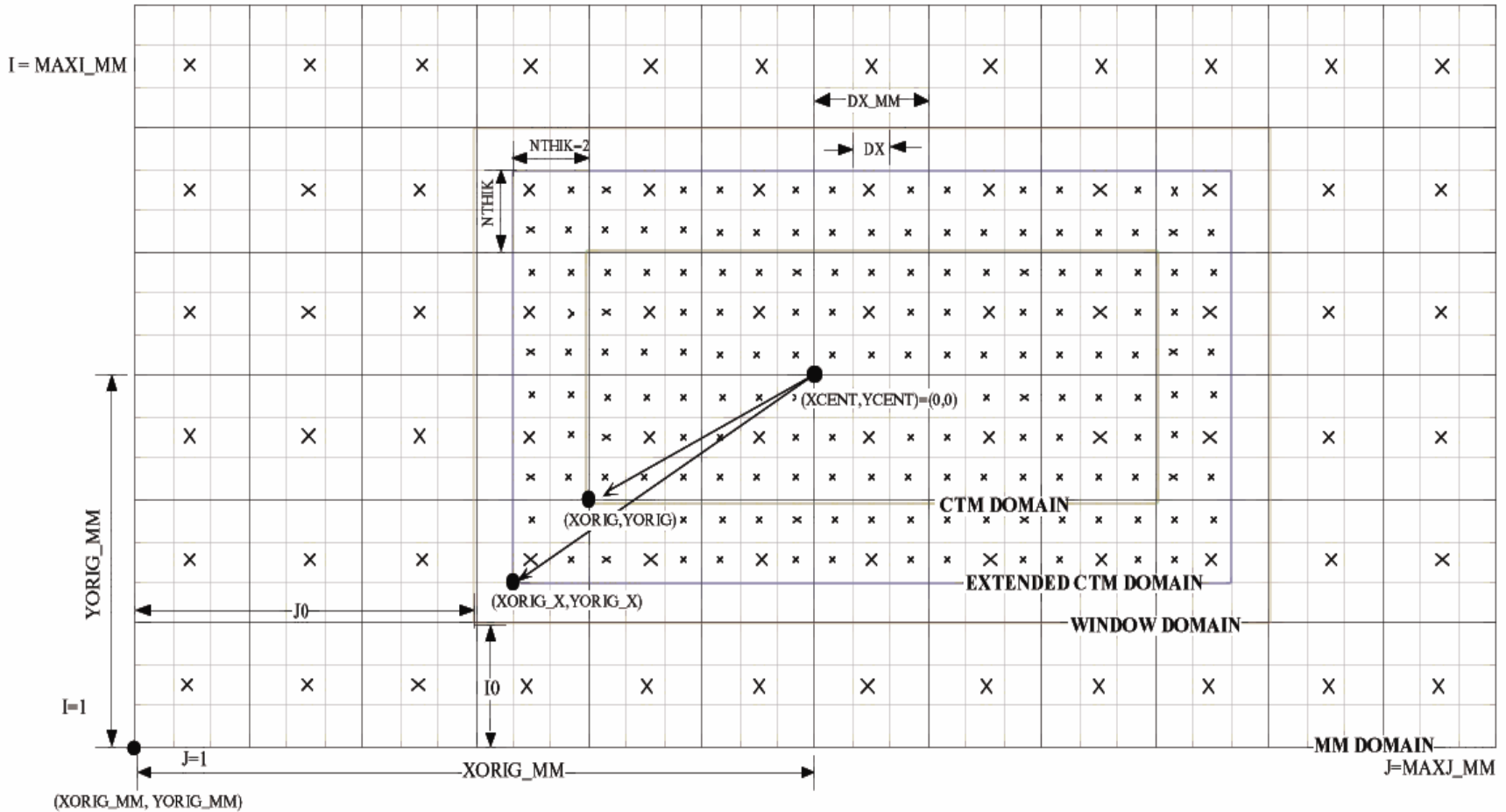
CMAQ Domain  
Dot & Cross

Boundary  
Domain



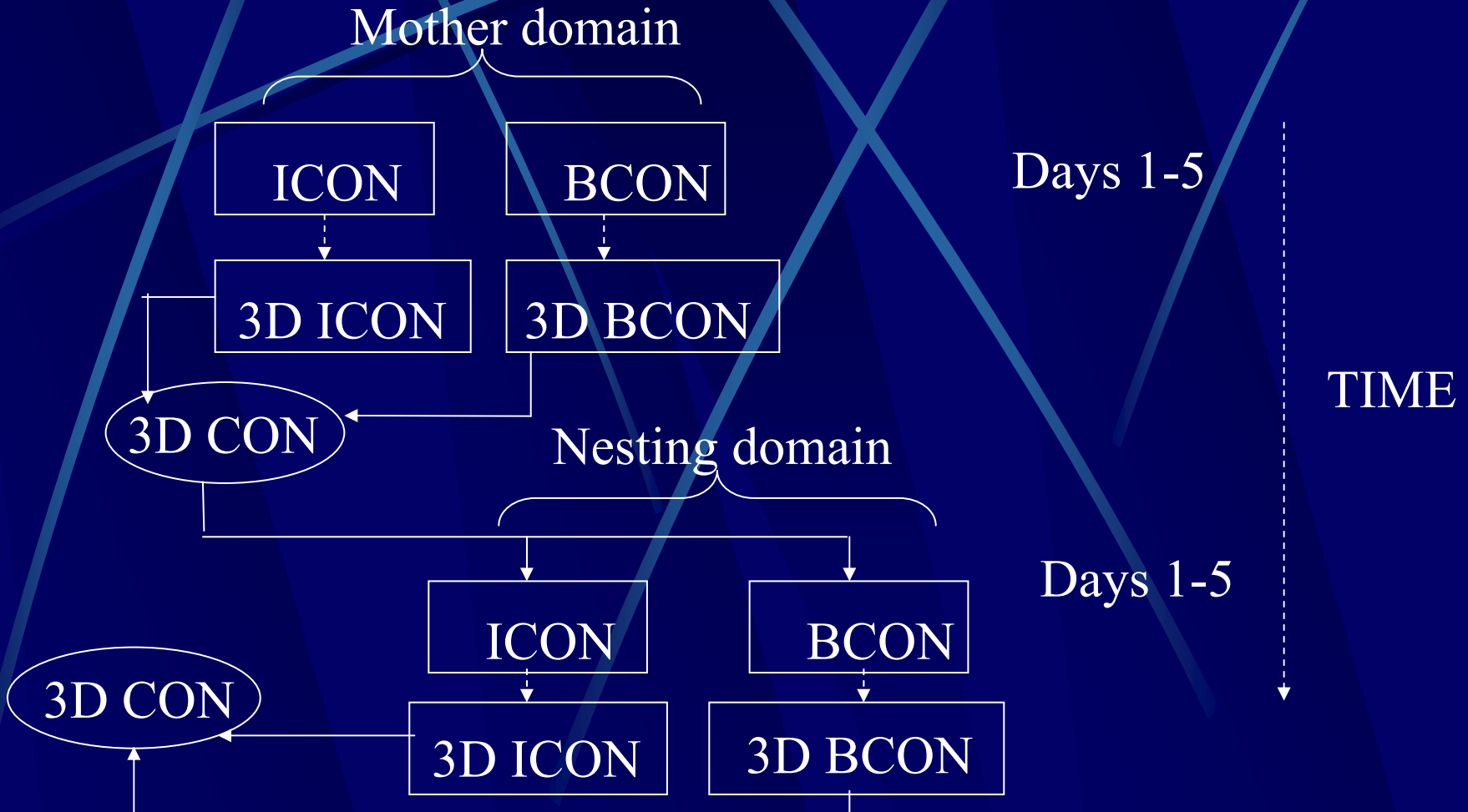
# THE CMAQ MODELLING SYSTEM: MM5-CMAQ LINKING

Relations among MM grid, extended-CTM grid, and CTM grid for NDX=3



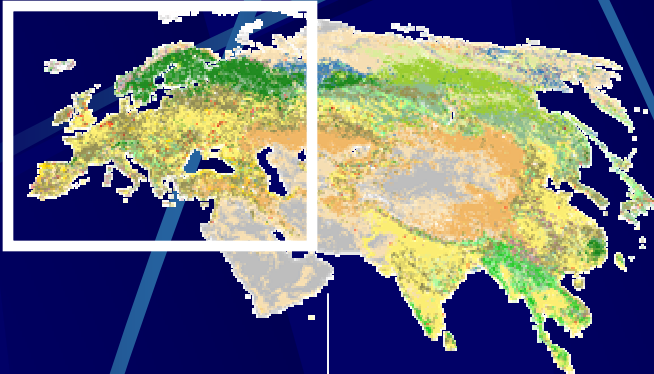


# SINGLE-DAY NEST



# LAND-USE DATA (I)

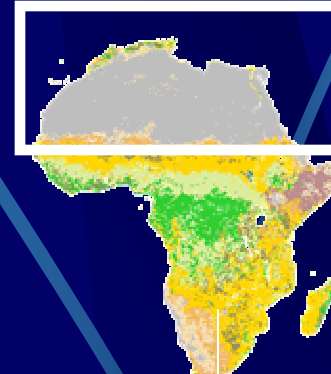
Eurasia Land Cover Characteristics Data Base Lambert Azimuthal Equal Area Projection



ARC/INFO

EURASIA-CMAQ-DOMAIN Lambert Conformal Conic

Africa Land Cover Characteristics Data Base Lambert Azimuthal Equal Area Projection



ARC/INFO

AFRICA-CMAQ-DOMAIN Lambert Conformal Conic



# LAND-USE DATA (II)

**EURASIA-CMAQ-  
DOMAIN Lambert  
Conformal Conic**

**AFRICA-CMAQ-DOMAIN  
Lambert Conformal Conic**

**LAND-USE ADD PROGRAM**

**EURASIA-AFRICA-CMAQ-DOMAIN**

**Lambert Conformal Conic.**

**Resolution = 4000m**

**Rows = 1600**

**Cols = 2000**

**X0 = -4000000**

**Y0 = -3200000 (Luproc Format)**



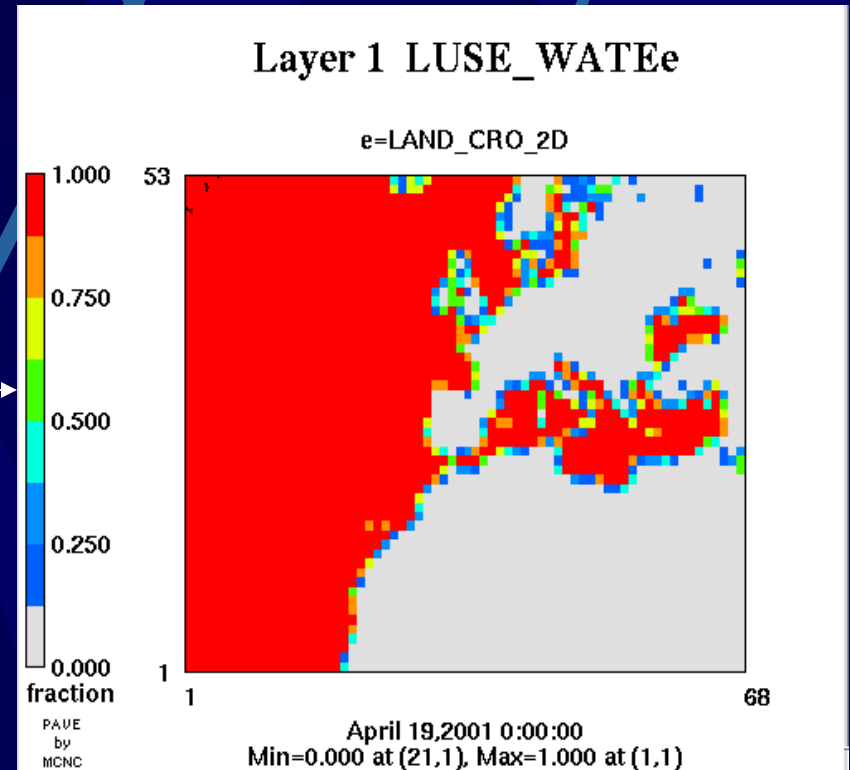
# LAND-USE DATA (III)

EURASIA-AFRICA-CMAQ-DOMAIN

Lambert Conformal Conic.

Resolution = 4000m

LUPROC

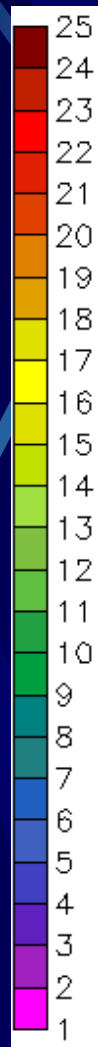
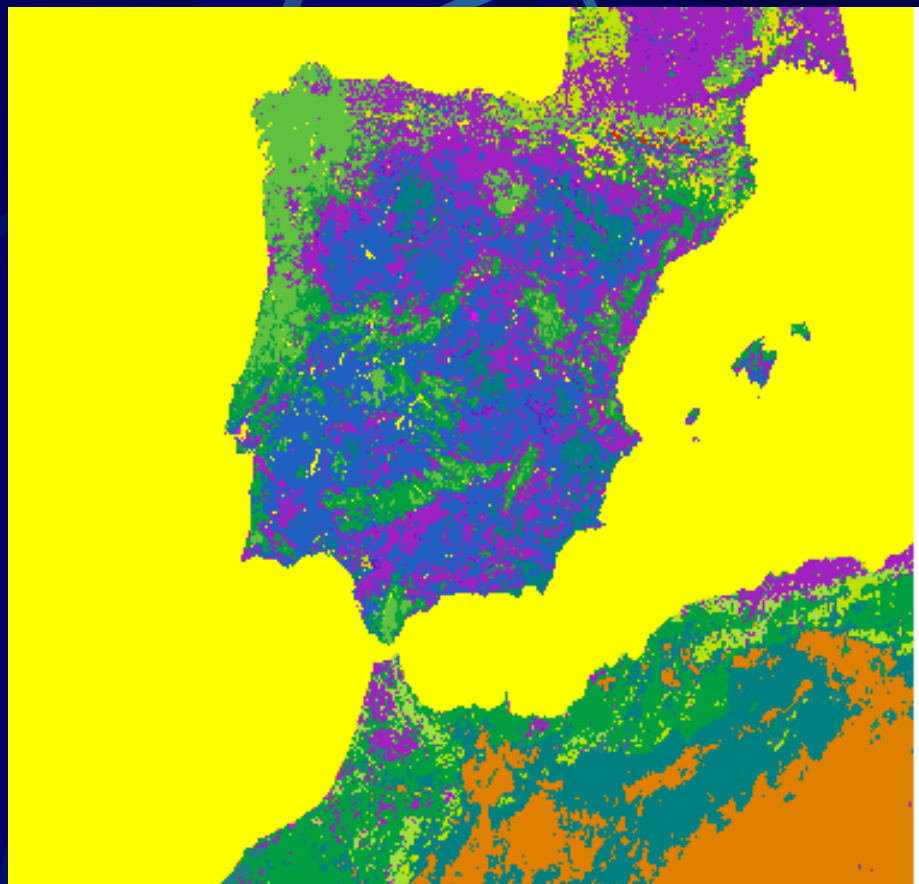


Water Land-Use



# LANDUSE DATA

USGS Land Use/Land Cover System  
Legend (Modified Level 2)



- 24 Snow or Ice
- 23 Bare Ground Tundra
- 22 Mixed Tundra
- 21 Wooded Tundra
- 20 Herbaceous
- 19 Barren or Sparsely Vegetated
- 18 Wooded Wetland
- 17 Herbaceous Wetland
- 16 Water Bodies
- 15 Mixed Forest
- 14 Evergreen Needleleaf Forest
- 13 Evergreen Broadleaf
- 12 Deciduous Needleleaf Forest
- 11 Deciduous Broadleaf
- 10 Savanna
- 9 Mixed Shrubland/Grassland
- 8 Shrubland
- 7 Grassland
- 6 Cropland/Woodland Mosaic
- 5 Cropland/Grassland
- 4 Mixed Dryland/Irrigated Cropland and Pasture
- 3 Irrigated Cropland and Pasture
- 2 Dryland Cropland and Pasture
- 1 Urban and Built-Up Land

USGS LANDUSE 1KM RESOLUTION



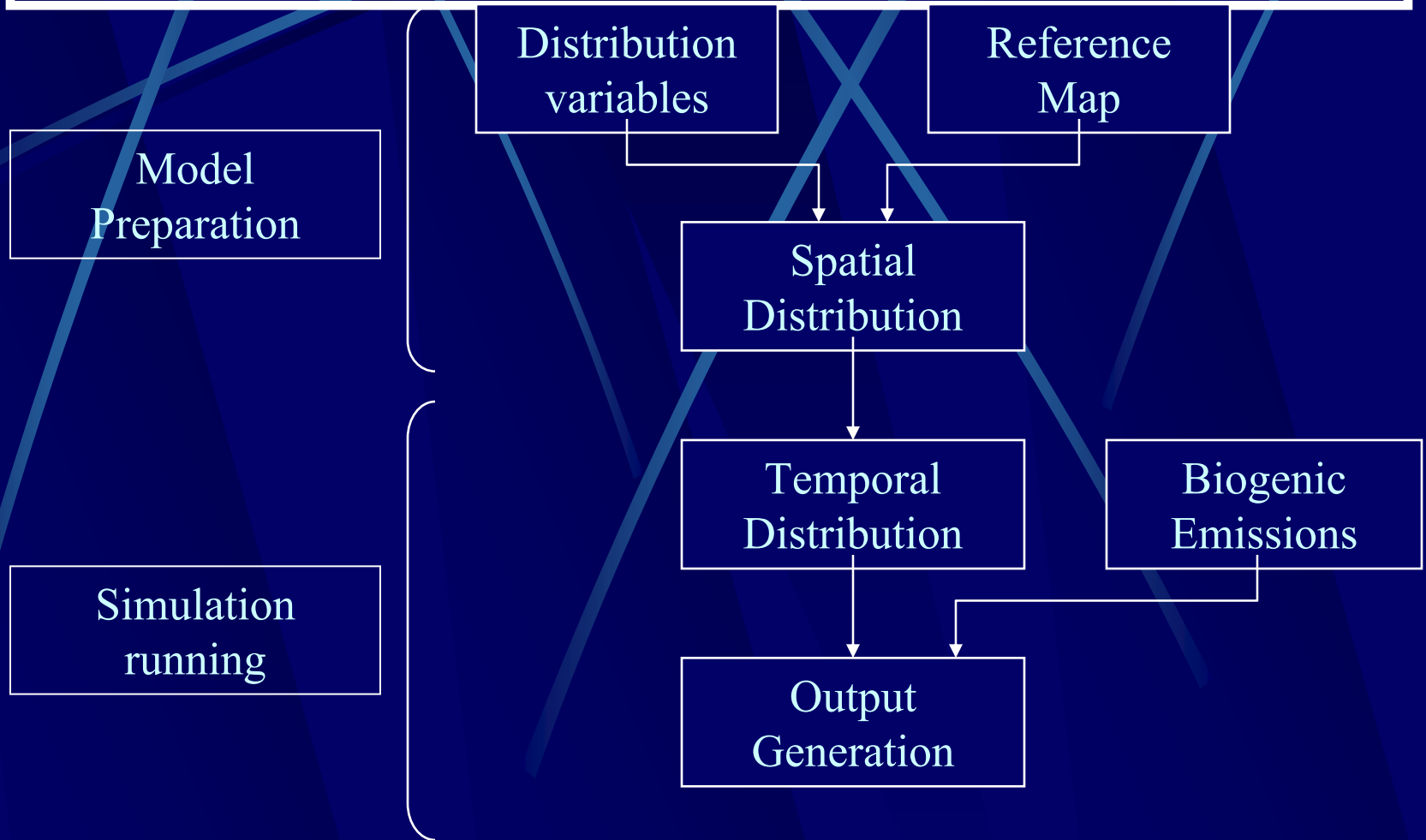
# EMISSION MODEL: EMIMO

EMIMO (EMIssion MOdel).

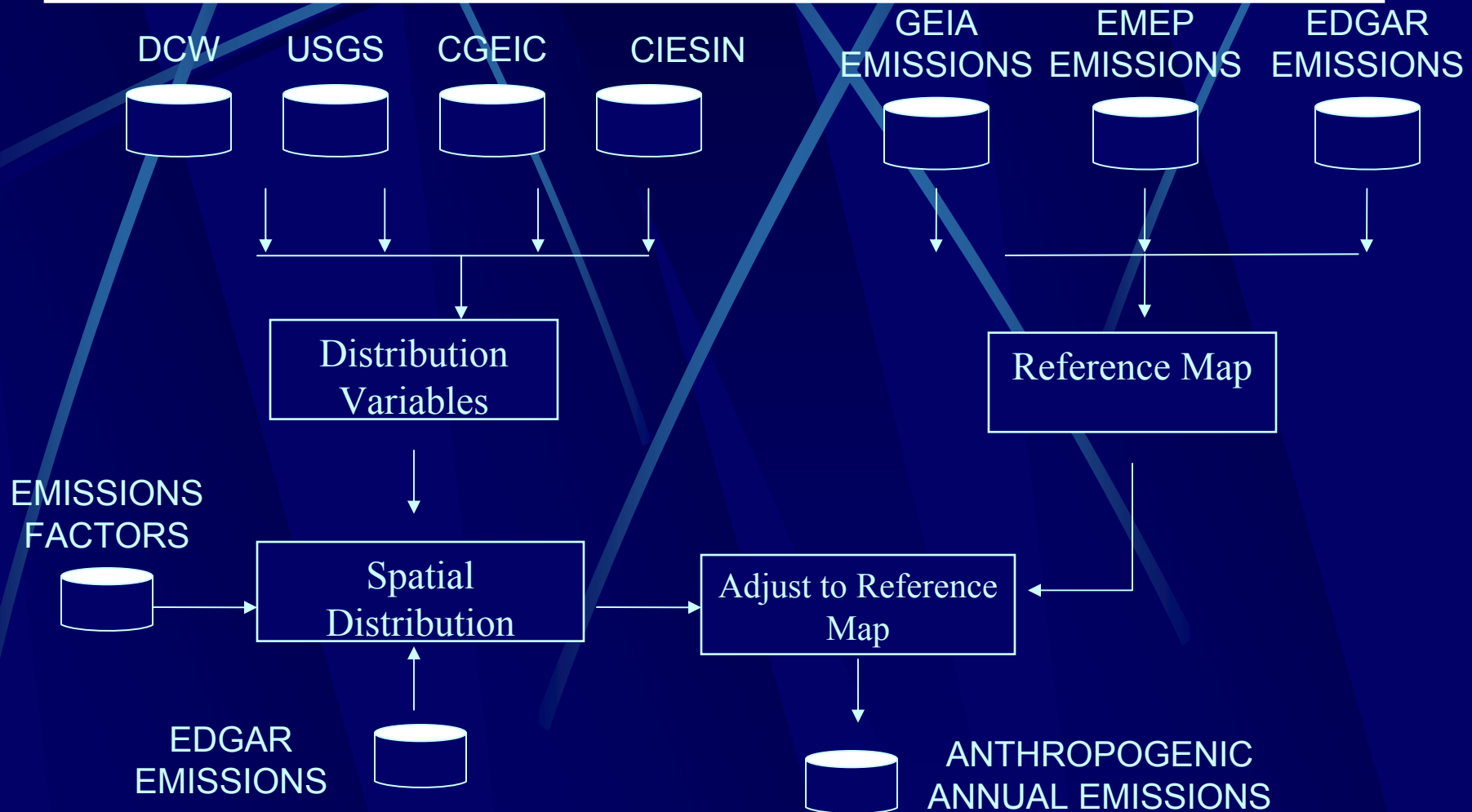
- ◆ Generation of large scale emission maps.
- ◆ World whole application.
- ◆ Hourly estimations for pollutants:
  - Anthropogenics: SO<sub>2</sub>, NO<sub>X</sub>, NMVOC, CO
  - Biogenics: Aerosols, Isoprene, biogenic VOC, biogenic NO<sub>X</sub>
- ◆ Geographic projection output.
- ◆ Cell size between 1 and 0.1 degrees.
- ◆ Graphic interface.



# EMIMO: MODEL DIAGRAM



# ANTHROPOGENIC ANNUAL EMISSIONS





# EMISSION DATA SETS FOR GLOBAL ATMOSPHERIC RESEARCH: EDGAR



RIJKSINSTITUUT VOOR VOLKSGEZONDHEID EN MILIEU  
NATIONAL INSTITUTE OF PUBLIC HEALTH AND THE ENVIRONMENT

The EDGAR database was to estimate the annual emissions of direct and indirect greenhouse gases ( $\text{CO}_2$ ,  $\text{CH}_4$ ,  $\text{N}_2\text{O}$ ;  $\text{CO}$ ,  $\text{NO}_x$ , non-methane VOC;  $\text{SO}_2$ ), including ozone-depleting compounds (halocarbons) for 1990 on a regional and grid basis.

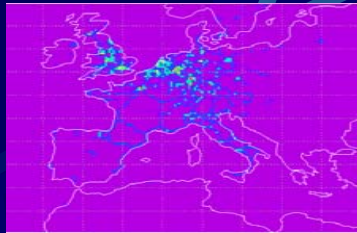
1x1 degree resolution (altitude resolution of 1 km), as agreed upon in the Global Emissions Inventory Activity (GEIA) of the International Atmospheric Chemistry Programme (IGAC).

It includes anthropogenic and biogenic emissions

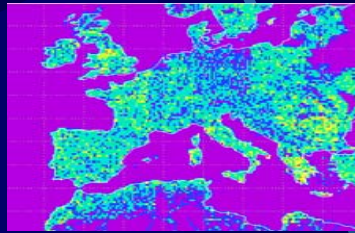


# Variable distribution: multiple regression process

HIGHWAYS



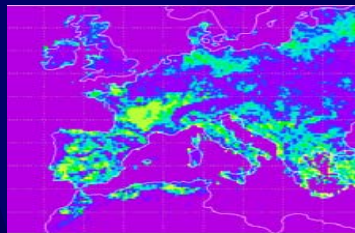
ROADS



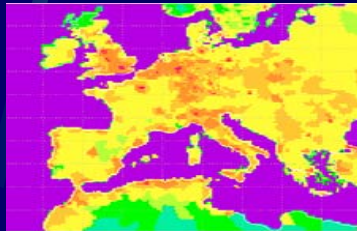
URBAN USE



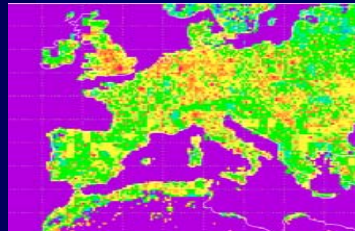
AGRICULTURAL USE



REGIONAL POP.



POPULATION



## 9 distribution variables :

### ◆ 3 Roads:

Digital Chart of the Word (Pennsylvania State University)

### ◆ 4 Land uses:

USGS (*U.S. Geological Survey*)

### ◆ 2 Population:

• CIESIN (*Centre of International Earth Science Information Network*)

• CGEIC (*Canadian Global Emission Interpretation Centre*)



# EMISSION DATA

EMIMO V2.0

EMISSION DATA  
Latitud-  
Longitude Projection

EMIMA V2.0

EMISSION DATA  
UTM Projection

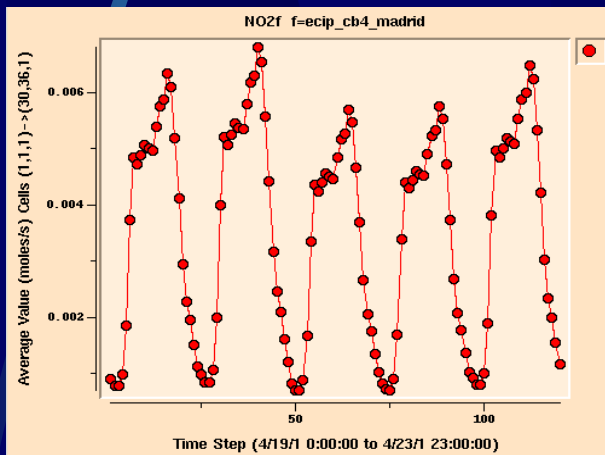
GRASS-GIS

EMISSION DATA  
Lambert Conformal Projection

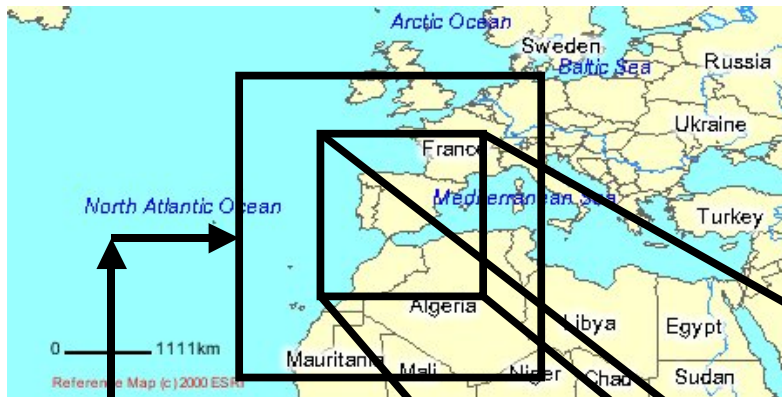
FORMAT

EMISSION DATA  
Lambert Conformal  
Projection  
(ECIP Format)

ECIP



# THE MM5-CMAQ MODELLING SYSTEM

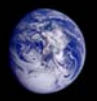


**Mother Domain**  
36 x 36 x 23  
81 km grid cell

**Nesting  
Level 1  
Model domain**



**Nesting  
Level 1:**  
  
69 x 66 cells  
  
27 km  
Spatial  
resolution



# THE MM5-CMAQ MODELLING SYSTEM

Nesting level 2: 54 x 54 x 23 (9 km)

Nesting level 3:  
33 x 39 x 23 (3 km)



## MM5-CMAQ Process Analysis



Environmental Software and Modelling  
Group <http://artico.lma.fi.upm.es>



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# AVN/MRF GLOBAL METEOROLOGICAL INITIAL DATASETS



ARL Web Server



# AVN/MRF GLOBAL METEOROLOGICAL INITIAL DATASETS

MODEL	DOMAIN	TIME RUN (UTC)	FORECAST DURATION (h)	TEMPORAL RESOLUTION (h)	SPATIAL RESOLUTION (km)	OUTPUT RESOLUTION (km)	MODEL LEVELS
<u>RAMS FG</u>	<u>Variable</u>	12	36	1	4	4	25
<u>RAMS CG</u>	<u>Variable</u>	12	36	1	16	16	25
<u>Eta (40)</u>	<u>United States</u>	00/06/12/18	48	3	32	40	26
<u>Eta (91)</u>	<u>North America</u>	00/12	48	6	32	91	19
<u>NGM (91)</u>	<u>North America</u>	00/12	48	3	91	91	19
<u>RUC</u>	<u>United States</u>	0/3/6/9/12/15/18/21	12	3	40	40	26
<u>AVN</u>	<u>NH / SH</u>	00/06/12/18	84	6	~106	191	13
<u>AVN</u>	<u>NH</u>	00/06/12/18	48	3	~106	111	23
<u>MRF</u>	<u>NH / SH</u>	00	288	12	~106	191	13
<u>MM5</u>	<u>United States</u>	06/18	48	3	15	15	24
<u>MM5</u>	<u>North America</u>	00/06/12/18	72	3	45	45	24



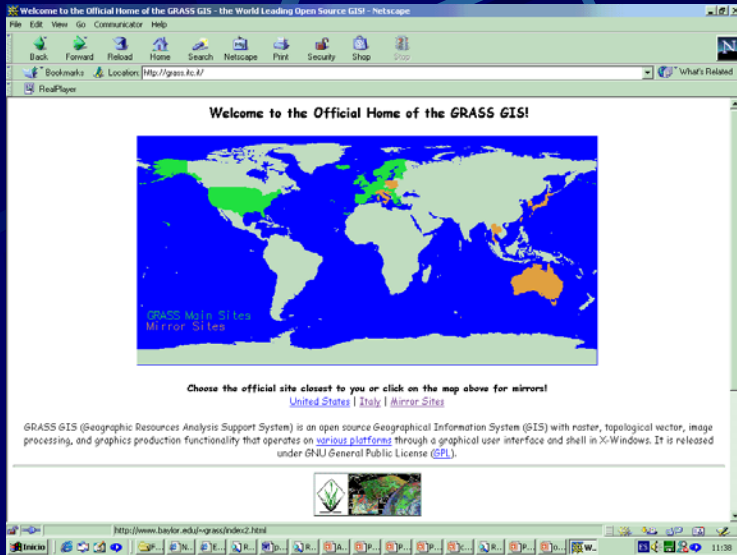
# Visualization & Analysis system

- **PAVE: Package for Analysis & Visualization of Environmental Data.**
- **GNU OCTAVE: A high-level interactive language for numerical computations.**
- **FERRET: Interactive computer visualization an analysis environment**
- **GRADS: Grid Analysis and Display System.**
- **FORMAT ADAPTERS PROGRAMS.**
- **NETCDF: Network Common Data Format libraries**





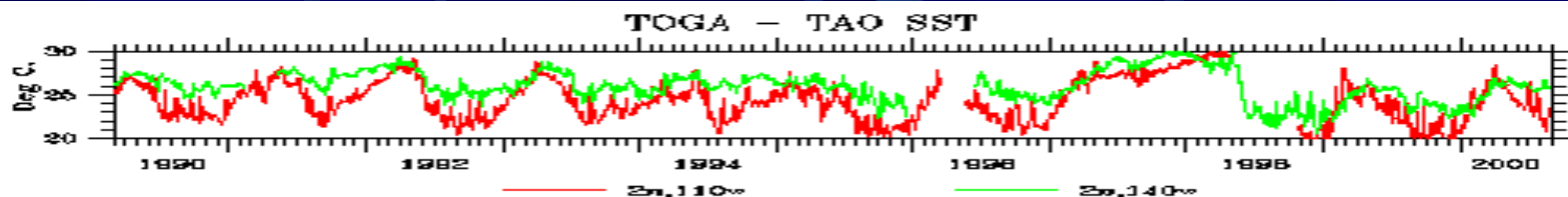
# Visualization tools: MM5-CMAQ



GRASS/GIS

GRADS /  
Grid Analysis and Display System

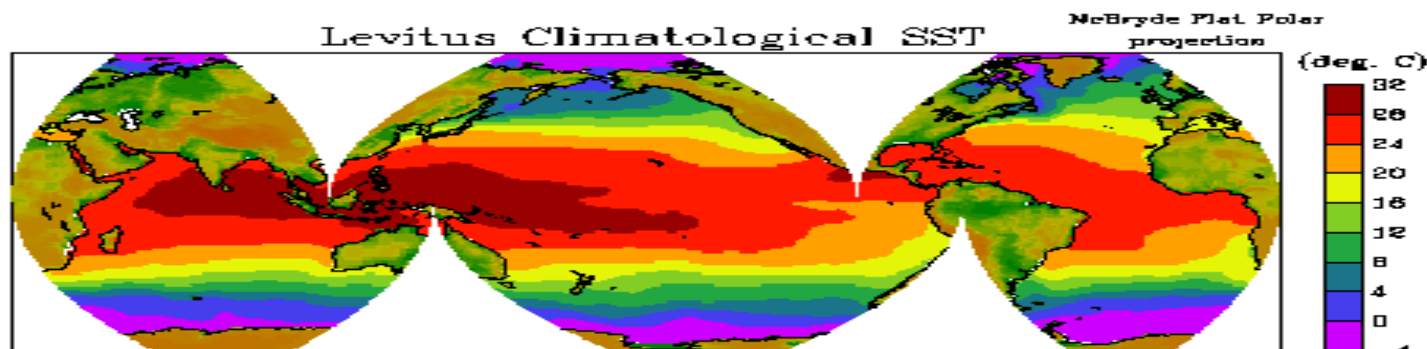




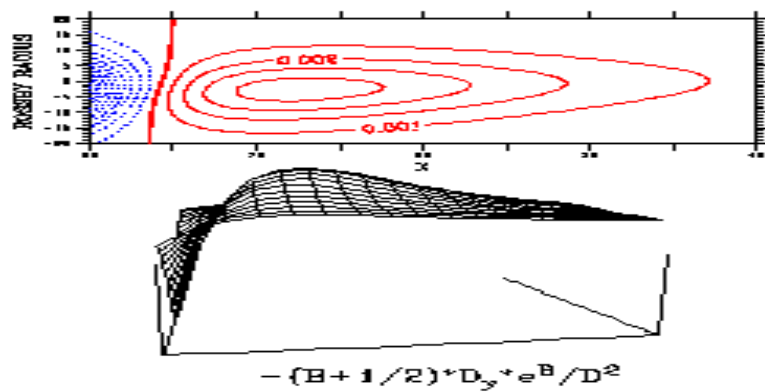
NOAA / PMEL

# F E R R E T

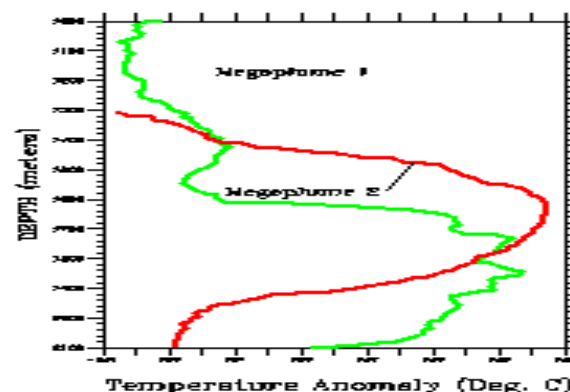
An Analysis Tool for Gridded Data



Perturbation Solution



VENTS Megaplume Thermal Structure

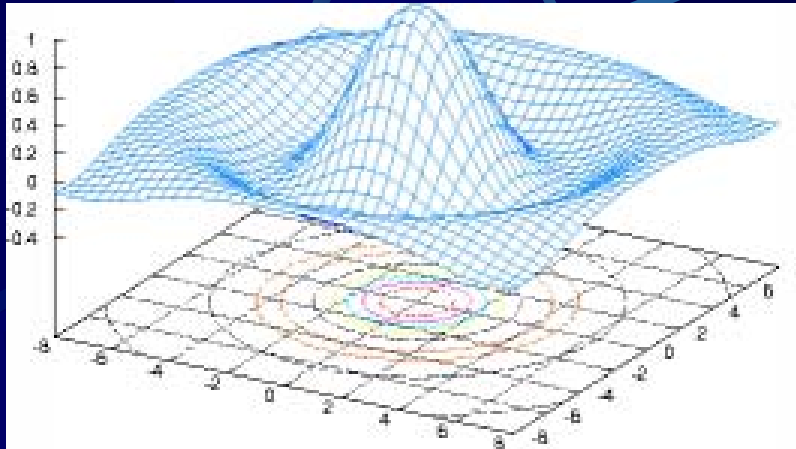


DCW / Pennsylvania State University



GEIA /  
Global Emission Inventory



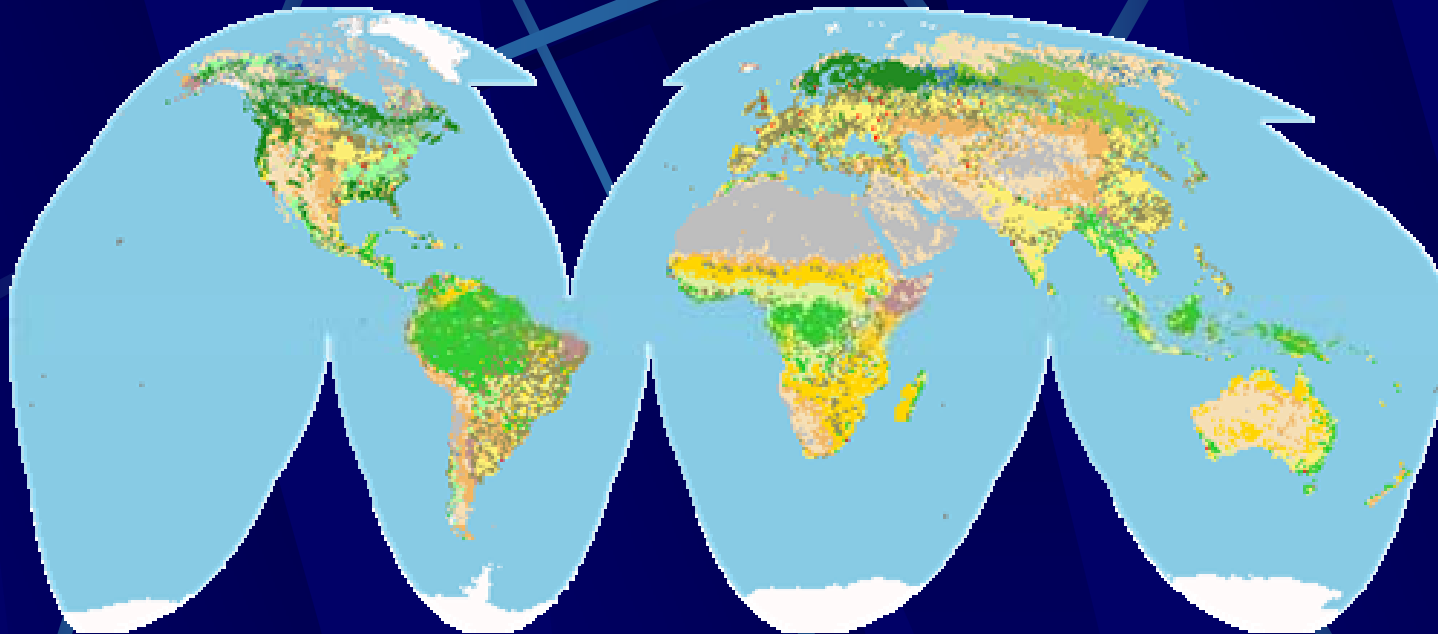


**OCTAVE / High Level  
Languaje for Numerical  
Computations / Department  
Of Chemical Engineering,  
Wisconsin University (USA)**

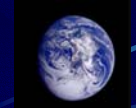


**GSTAT / Department of  
Geopgraphy / Utrecht  
University  
(The Netherlands)**





# USGS EROS Data Center



Environmental Software and Modelling  
Group <http://artico.lma.fi.upm.es>



**upm**  
UNIVERSIDAD POLITÉCNICA DE MADRID

# MM5-CMAQ (INTERNET)

CMAQ (U.S/EPA) Air Quality Forecasts over Iberian Peninsula: 27 km. spatial reso  
Environmental Software and Modelling Group Updated: oct 14 2002 // Ana

Select user options, press the request button, select an option on the right area and click on the map. Other available displays are: [AIR POLLUTION TIME SERIES](#)

Pollutants:

Time [hours]:

GIS OPTIONS  
Graphic Type:

Layers:  
 Road lines  
 Railroad lines  
 White Background Color  
 Political Boundaries:  
Boundary line color:   
Boundary thickness:

Request Data Pattern

Once you press the request button the map is drawn

[Help](#)

ZOOM-IN  
ZOOM-OUT  
PAN  
QUERY

03 MM5-CMAQ (ppb)

DATE: 21Z18OCT2002

2002-10-20-18:46

03 MM5-CMAQ (ppb)

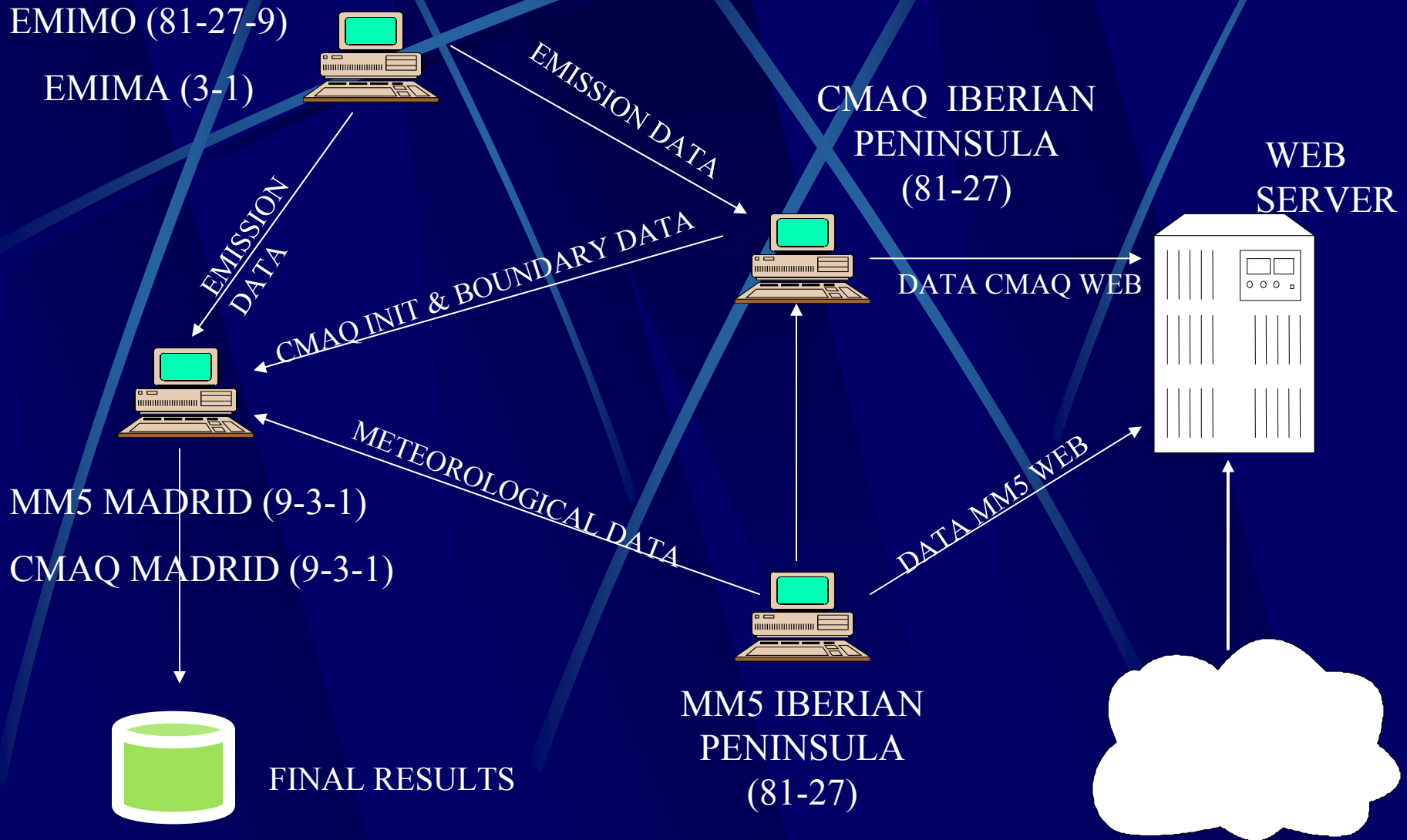
60  
45  
30  
15

00Z 18OCT 2002 12Z 18OCT 12Z 19OCT 12Z 19OCT 00Z 20OCT 12Z 20OCT

2002-10-20-18:55



# MM5 –CMAQ STRUCTURE





Atmospheric emissions

## OBJECTIVE:

1. To develop a tool to evaluate the air quality impact of industrial plants.
2. Test case study:
  - Madrid (Spain) domain
  - EDGAR Emission Inventory (RIVM, Holland) 1990 emission data base and EMIMO V2.0
  - Industrial plant located at the northern area of Madrid city
3. MODELS. MM5-CMAQ and OPANA



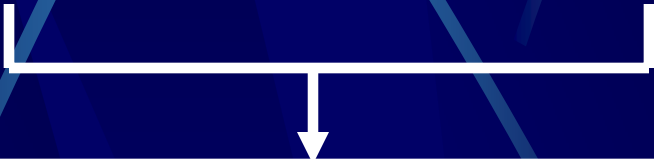
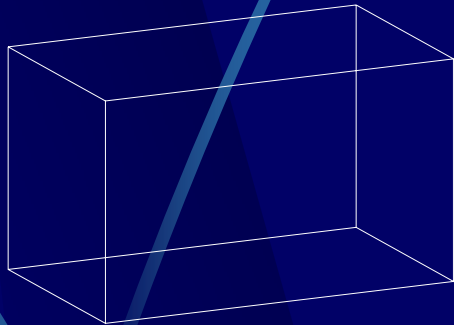
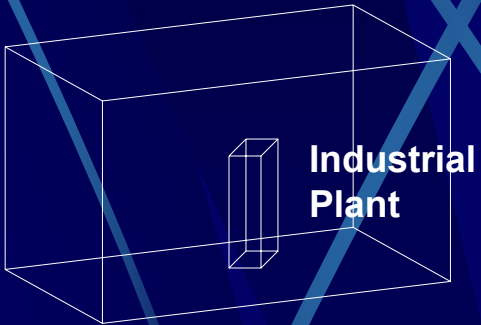


**TEAP**

**Taking decisions**

**ON**

**OFF**



**Differences = portion of air concentrations due to industrial emissions**



**TEAP**

**INTERNET USER**

**AVN/NCEP data  
Aprox. 1 GByte**

**INDUSTRIAL PLANT MANAGER  
SERVER**

**MM5**

**CMAQ / ON**

**Post-processor  
Differences**

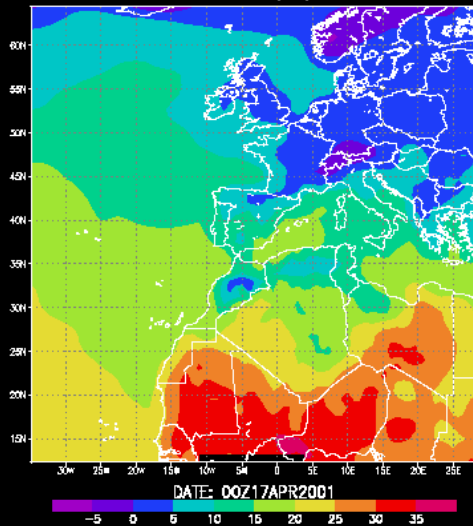
**CMAQ / OFF**

**CMAQ / X%**

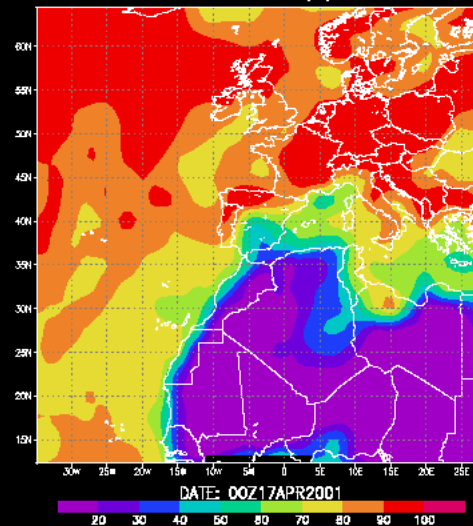
**CMAQ / X(n)%**

# THE MM5-CMAQ SYSTEM

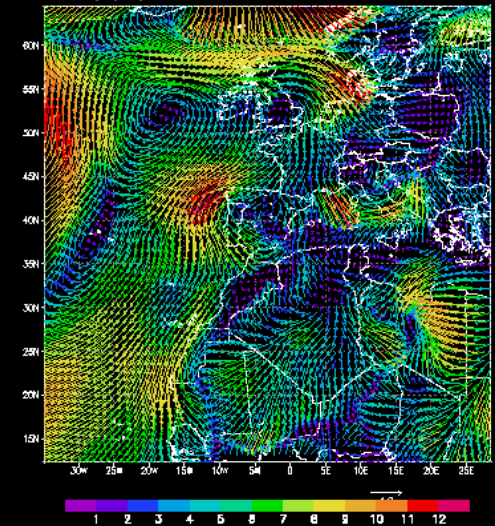
Environmental Software and Modelling Group, UPM (Madrid).  
36 M. TEMPERATURE (C) MM5 - CMAQ



Environmental Software and Modelling Group, UPM (Madrid).  
36 M. RELATIVE HUMIDITY (%) MM5 - CMAQ



Environmental Software and Modelling Group, UPM (Madrid).  
WIND (M/S) MM5 - CMAQ DATE: 00Z17APR2001



Temperature, relative humidity and surface winds produced by MM5 at 0Z, April, 17, 2001 (32 m above Sea level)



Environmental Software and Modelling Group <http://artico.lma.fi.upm.es>

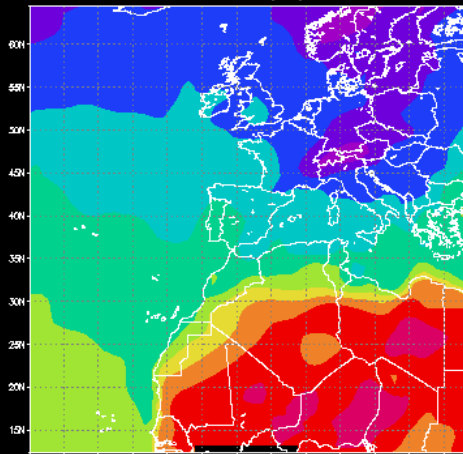


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# THE MM5-CMAQ SYSTEM

Environmental Software and Modelling Group, UPN (Madrid),  
36 M. TEMPERATURE (C) MM5 - CMAQ



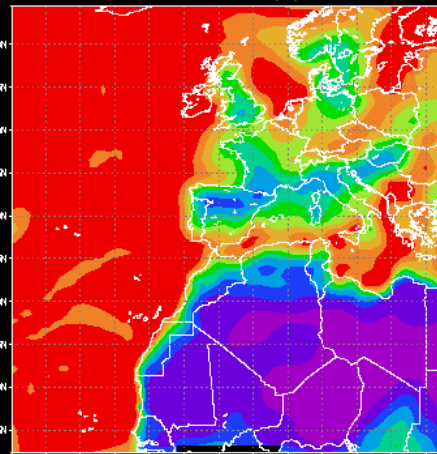
DATE: 14Z20APR2001



QARS CIL/SES

2001-08-08-1004

Environmental Software and Modelling Group, UPN (Madrid),  
36 M. RELATIVE HUMIDITY (%) MM5 - CMAQ



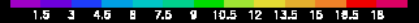
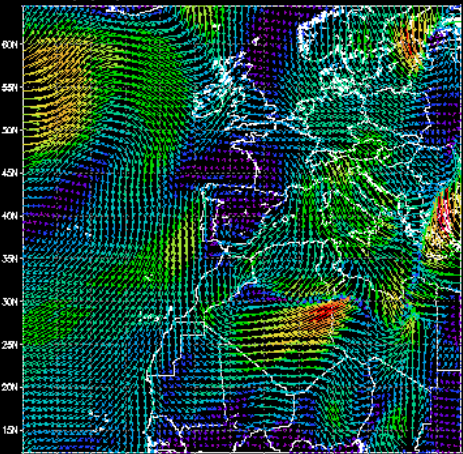
DATE: 14Z20APR2001



QARS CIL/SES

2001-08-08-0905

Environmental Software and Modelling Group, UPN (Madrid),  
WIND (M/S) MM5 - CMAQ DATE: 14Z20APR2001



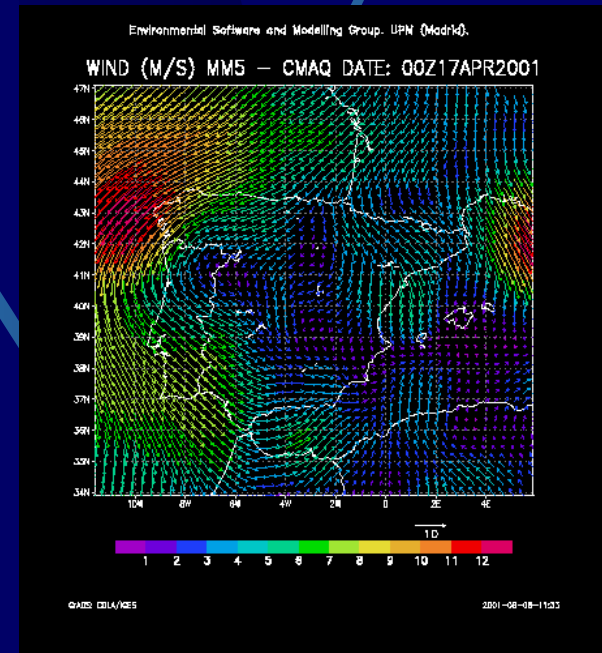
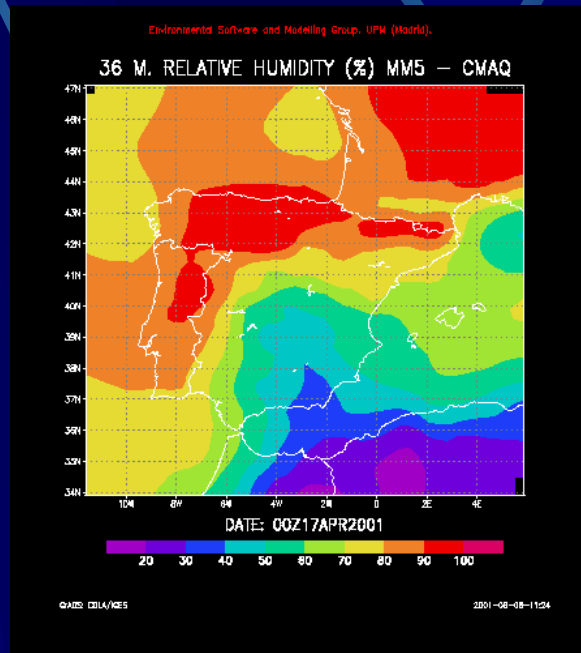
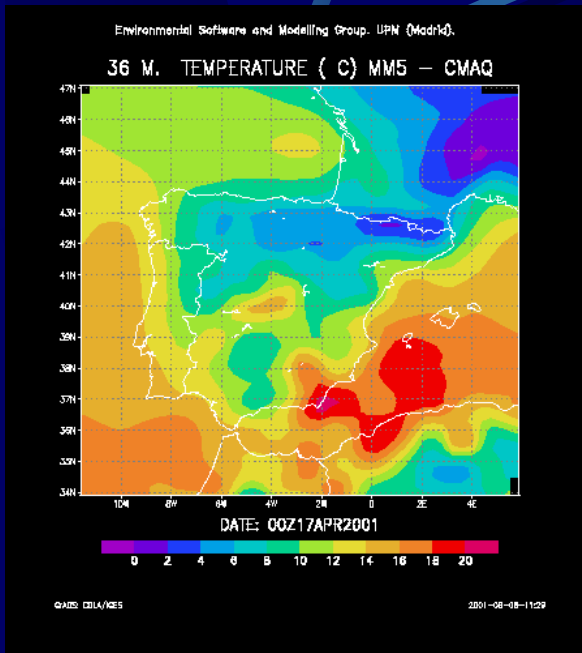
QARS CIL/SES

2001-08-08-1018

Temperature, relative humidity and surface winds produced by MM5 at 14Z, April, 20, 2001 (32 m above Sea level)



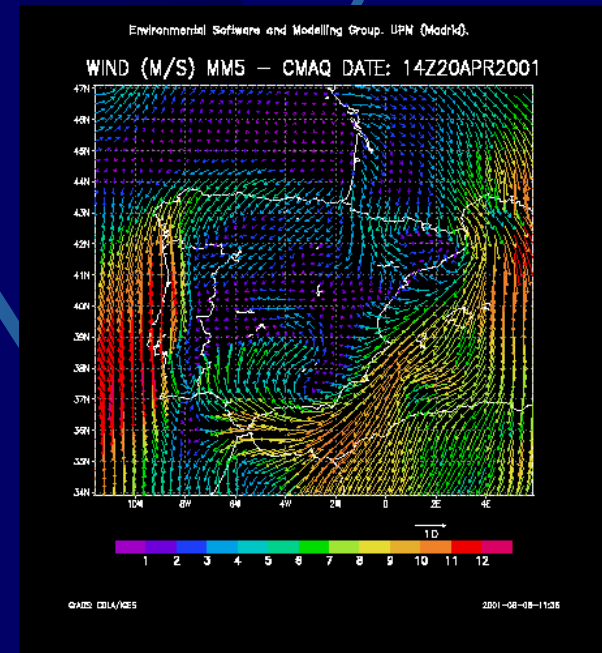
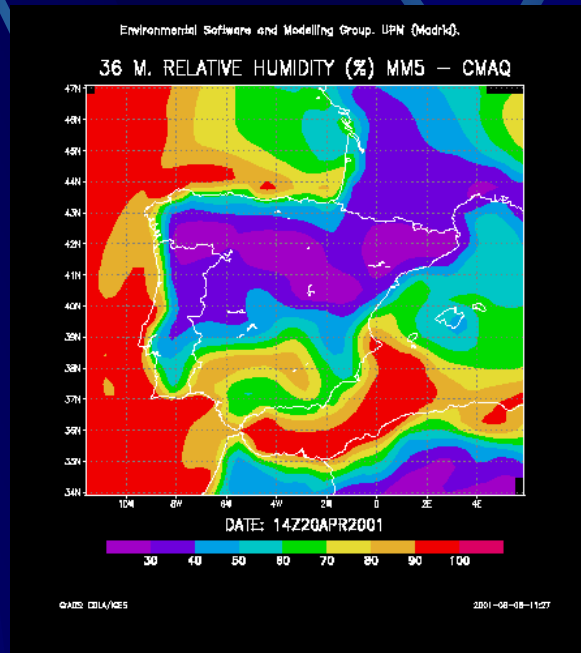
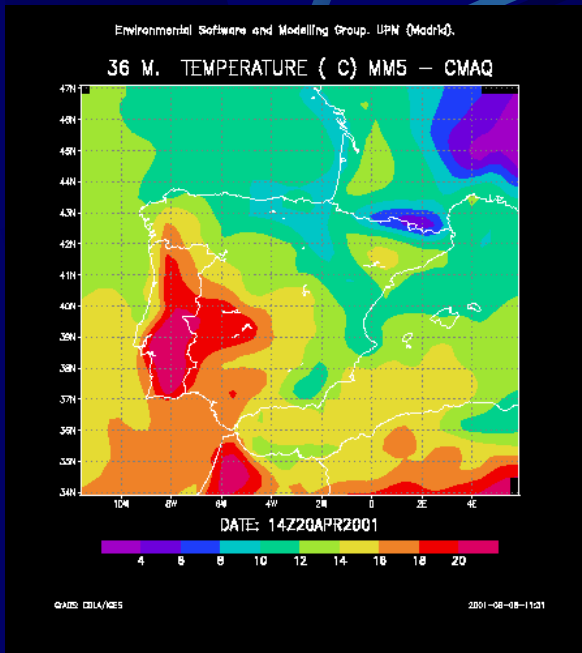
# THE MM5-CMAQ SYSTEM



Temperature, relative humidity and surface winds produced by MM5 at 0Z, April, 17, 2001 (32 m above Sea level). Nesting level 1 (Iberian Peninsula).



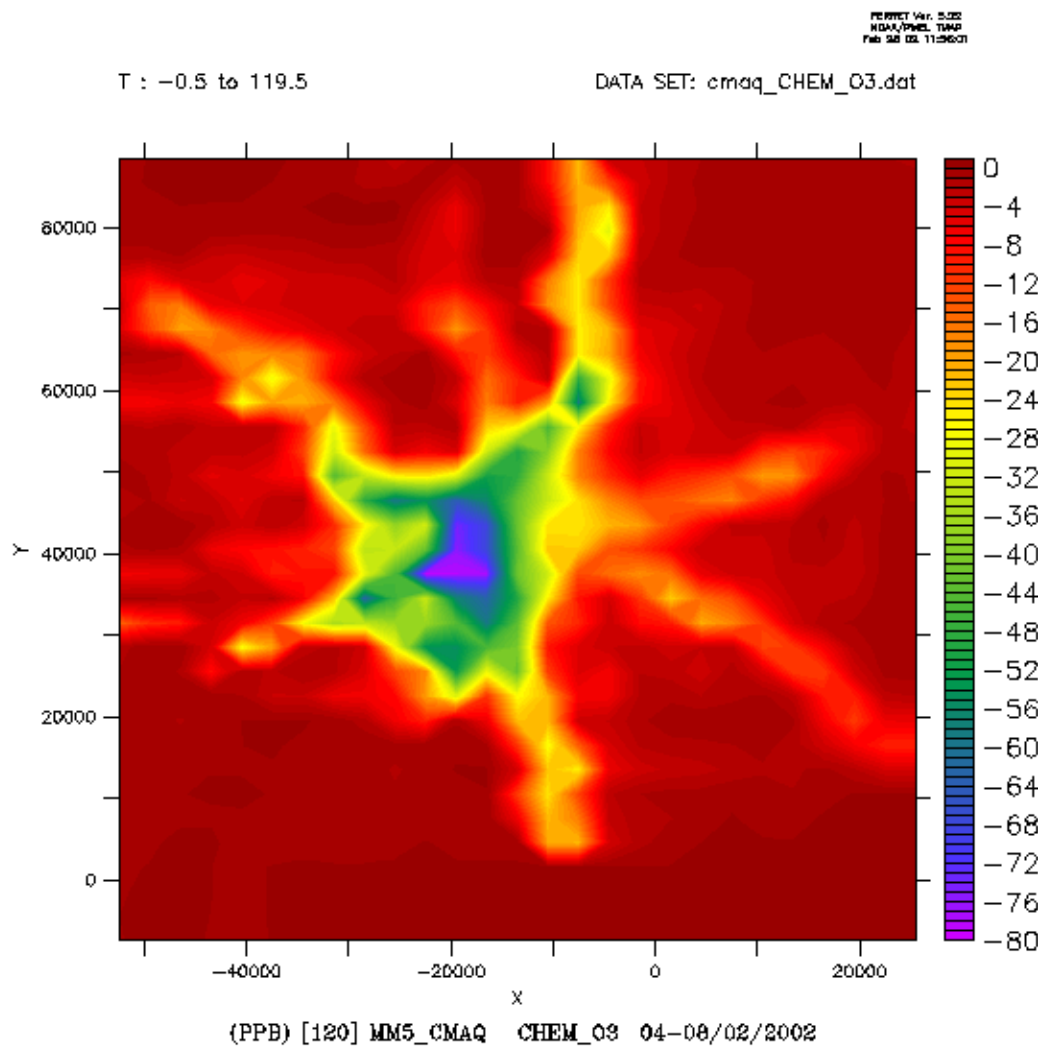
# THE MM5-CMAQ SYSTEM



Temperature, relative humidity and surface winds produced by MM5 at 14Z, April, 20, 2001 (32 m above Sea level). Nesting level 1 (Iberian Peninsula).



# MM5-CMAQ PROCESS ANALYSIS



## MM5-CMAQ PROCESS ANALYSIS:

FEBRUARY, 4-8, 2002

MADRID, NESTING LEVEL 3  
(3 KM SPATIAL  
RESOLUTION)

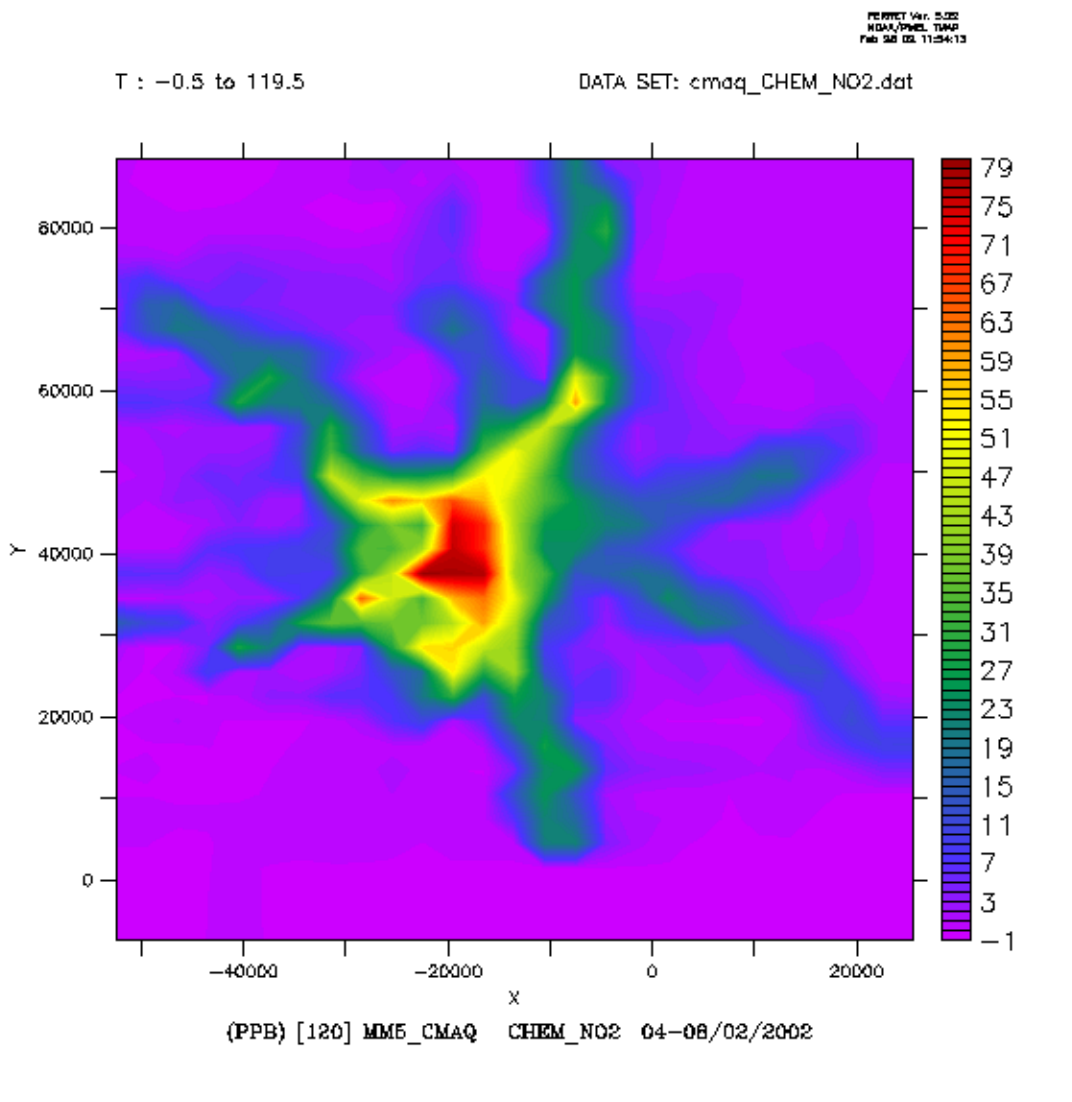
AVERAGE OVER 120  
HOURS

CHEMICAL PROCESS ON  
O<sub>3</sub>  
FORMATION

CHANGE IN OZONE  
CONCENTRATIONS  
CAUSED  
BY CHEMICAL PROCESSES



# MM5-CMAQ PROCESS ANALYSIS



## MM5-CMAQ PROCESS ANALYSIS:

FEBRUARY, 4-8, 2002

MADRID, NESTING LEVEL 3  
(3 KM SPATIAL  
RESOLUTION)

AVERAGE OVER 120  
HOURS

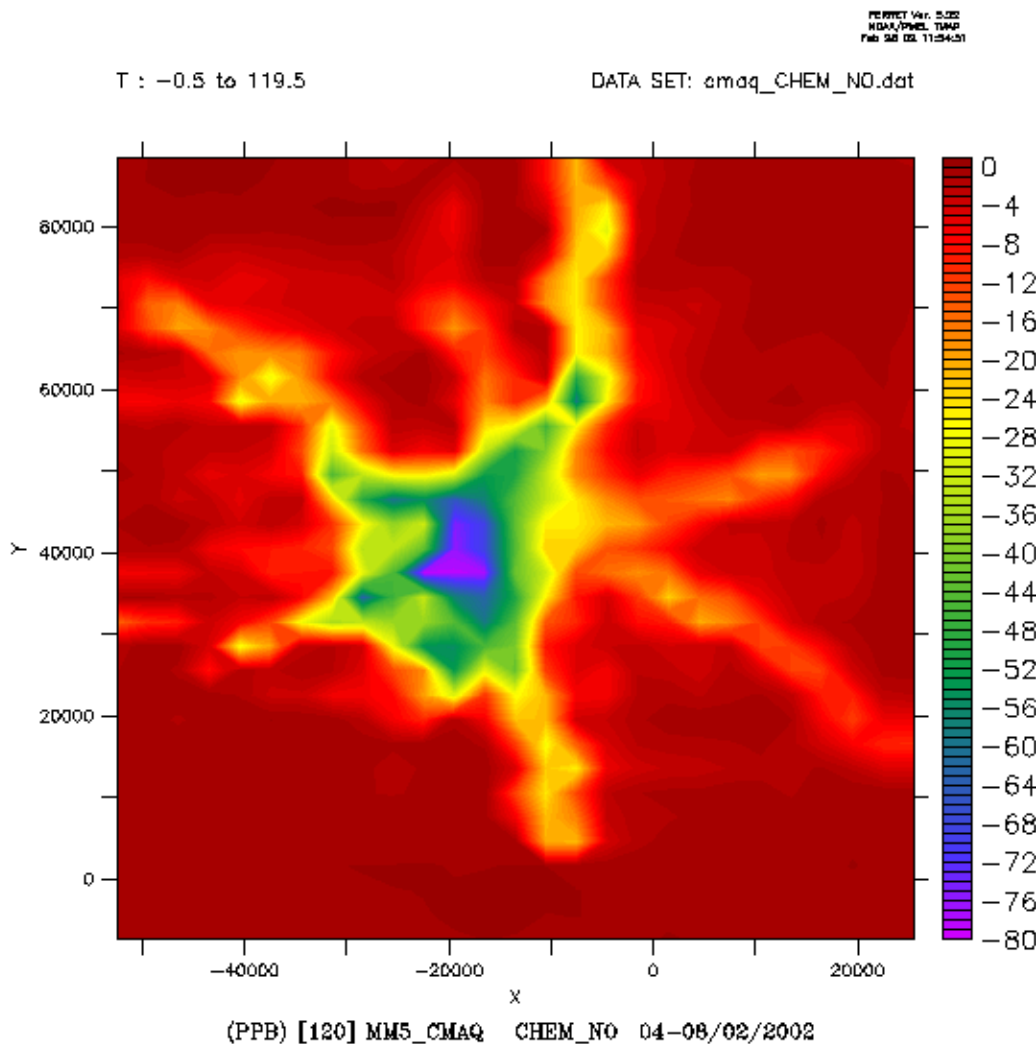
CHEMICAL PROCESS ON  
NO2  
FORMATION

CHANGE IN NO2  
CONCENTRATIONS  
CAUSED  
BY CHEMICAL PROCESSES





# MM5-CMAQ PROCESS ANALYSIS



## MM5-CMAQ PROCESS ANALYSIS:

FEBRUARY, 4-8, 2002

MADRID, NESTING LEVEL 3  
(3 KM SPATIAL  
RESOLUTION)

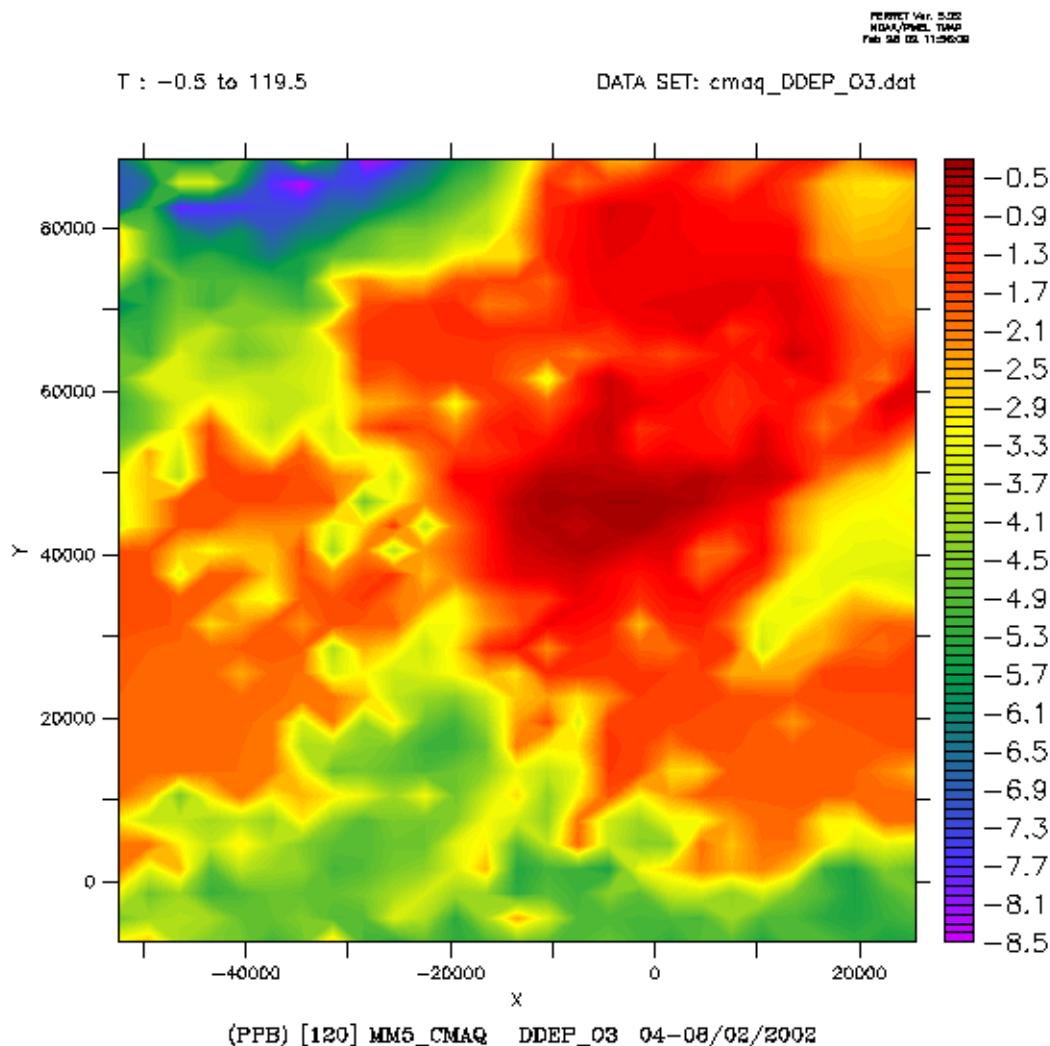
AVERAGE OVER 120  
HOURS

CHEMICAL PROCESS ON  
NO  
FORMATION

CHANGE IN NO  
CONCENTRATIONS  
CAUSED  
BY CHEMICAL PROCESSES



# MM5-CMAQ PROCESS ANALYSIS



## MM5-CMAQ PROCESS ANALYSIS:

FEBRUARY, 4-8, 2002

MADRID, NESTING LEVEL 3  
(3 KM SPATIAL RESOLUTION)

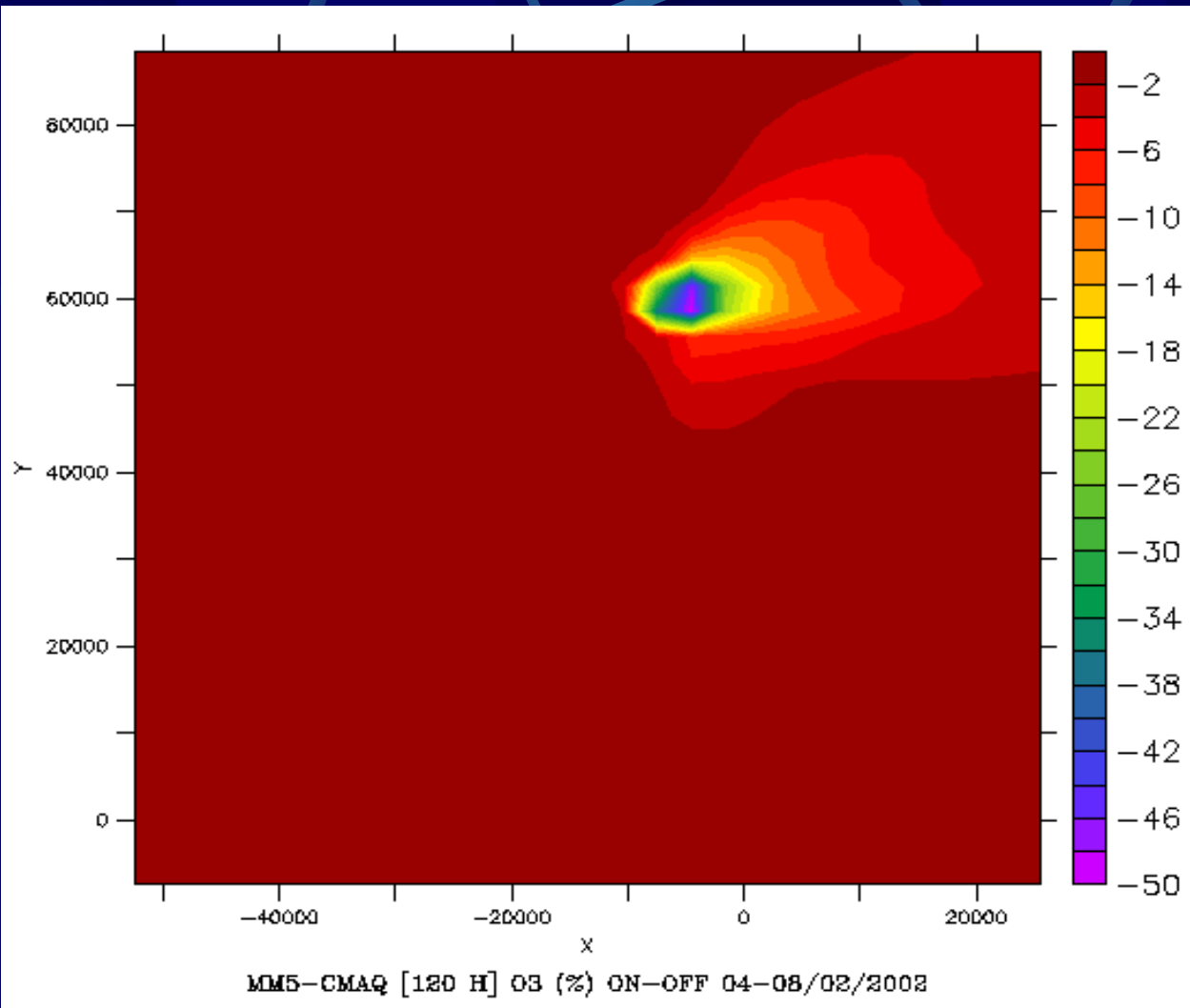
AVERAGE OVER 120 HOURS

DRY DEPOSITION PROCESS ON O3 FORMATION

CHANGE IN O3 CONCENTRATIONS CAUSED BY DRY DEPOSITION



# TEAP

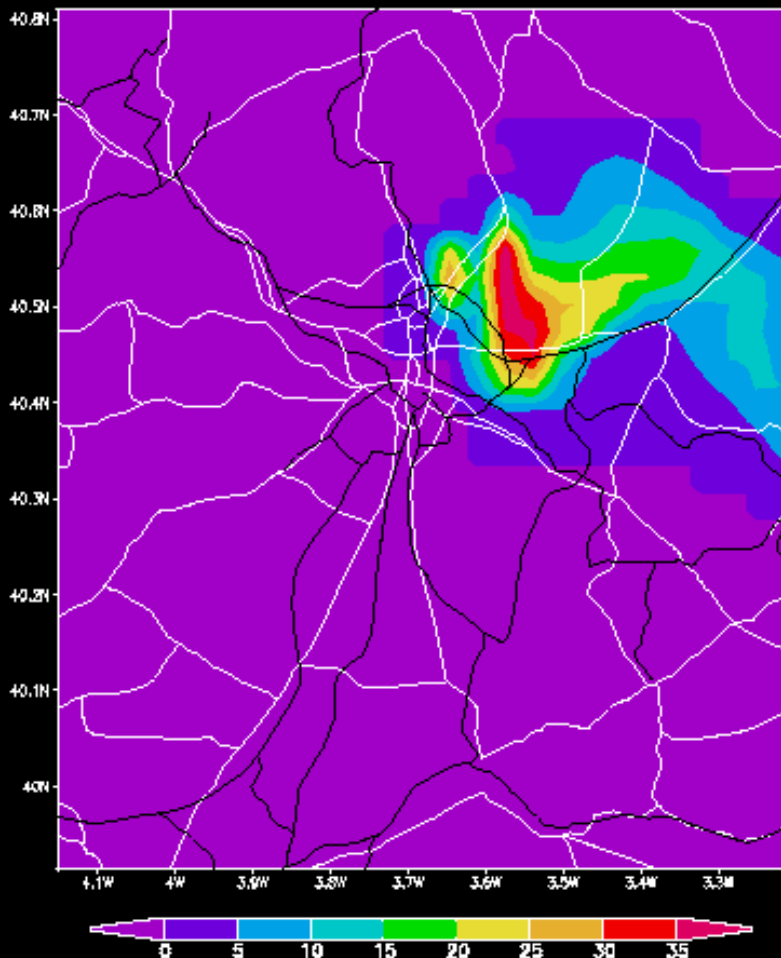


**120 hour  
average  
for the  
differences  
between  
simulation  
with industrial  
plant (ON) and  
simulation  
without the  
industrial  
plant (OFF) with  
the MM5-CMAQ  
model**



**TEAP**

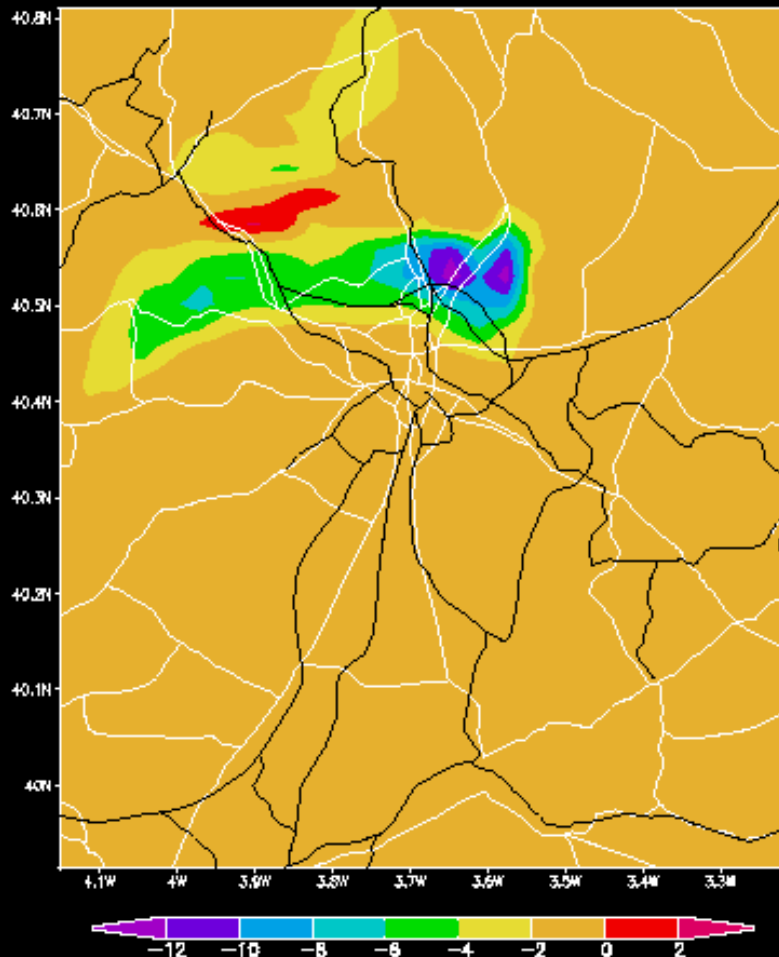
ON-OFF MM5-CMAQ NO2 (%) 03Z05FEB2002



**NO2 percentage  
impact by the industrial  
source at 03h00 on  
February, 5, 2002 with  
MM5-CMAQ modelling  
system over the Madrid  
domain**



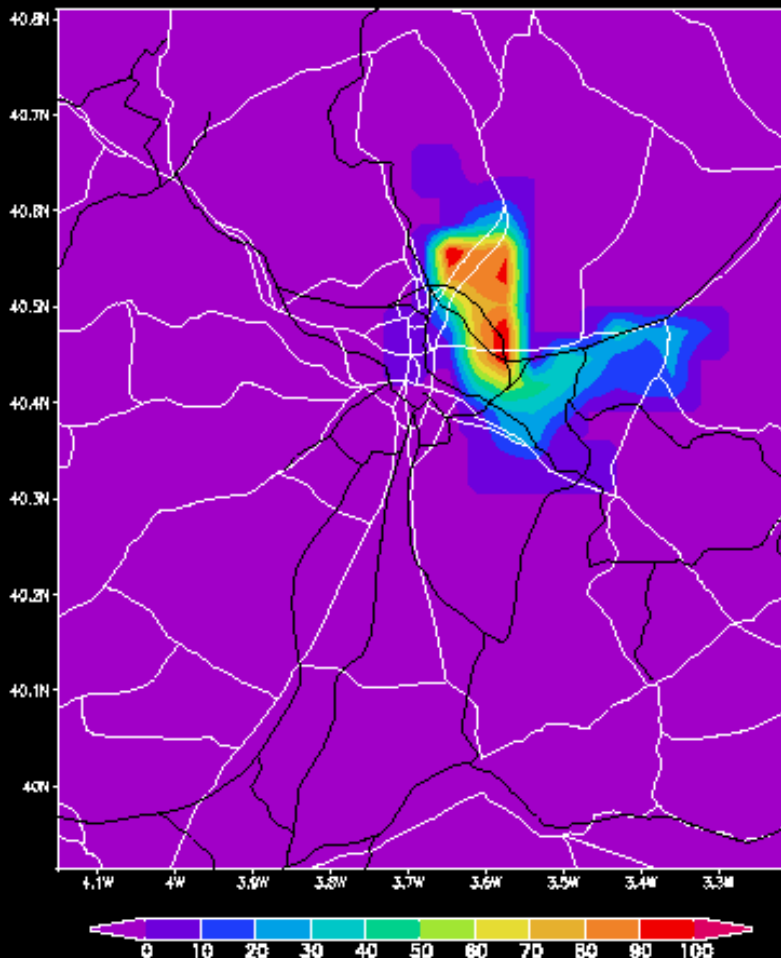
ON-OFF MM5-CMAQ O3 (%) 08Z04FEB2002



Ozone percentage impact by the industrial source at 08h00 on February, 4, 2002 with MM5-CMAQ modelling system over the Madrid domain



ON-OFF MM5-CMAQ NO (%) 03Z05FEB2002



**NO percentage impact by the industrial source at 03h00 on February, 5, 2002 with MM5-CMAQ modelling system over the Madrid domain**



# MM5-CMAQ: PROCESS ANALYSIS



**MADRID  
MUNICIPALITY  
AIR QUALITY  
AUTOMATIC  
MONITORING  
NETWORK  
NETWORK**



# MADRID COMMUNITY AIR QUALITY MONITORING NETWORK

Comunidad de Madrid  
RED DE CONTROL DE  
LA CALIDAD DEL AIRE



Fase	Municipio	Captadores instalados
I	Alcalá de H.	SO <sub>2</sub> , CO, NO, NO <sub>2</sub> , PM <sub>10</sub> , CB (U <sub>A</sub> ),
I	Alcobendas	SO <sub>2</sub> , CO, NO, NO <sub>2</sub> , PM <sub>10</sub> , CB (U <sub>A</sub> ), BTX, Hidrocarburos, Captador de COVs, Lluvia ácida
I	Getafe	SO <sub>2</sub> , CO, NO, NO <sub>2</sub> , PM <sub>10</sub> , CB (U <sub>A</sub> ), BTX
I	Leganés	SO <sub>2</sub> , CO, NO, NO <sub>2</sub> , PM <sub>10</sub> , CB (U <sub>A</sub> ),
II	Alcorcón	SO <sub>2</sub> , CO, NO, NO <sub>2</sub> , PM <sub>10</sub> , CB (U <sub>A</sub> ),
II	Coslada	SO <sub>2</sub> , CO, NO, NO <sub>2</sub> , PM <sub>10</sub> , CB (U <sub>A</sub> ),
II	Fuenlabrada	SO <sub>2</sub> , CO, NO, NO <sub>2</sub> , PM <sub>10</sub> , CB (U <sub>A</sub> ), CB (quimioluminiscencia), BTX, Hidrocarburos, Captador de COVs
II	Móstoles	SO <sub>2</sub> , CO, NO, NO <sub>2</sub> , PM <sub>10</sub> , CB (U <sub>A</sub> ), Lluvia ácida
II	Torrejón de Ardoz	SO <sub>2</sub> , CO, NO, NO <sub>2</sub> , PM <sub>10</sub> , CB (U <sub>A</sub> ), CB (quimioluminiscencia), BTX, Hidrocarburos, Captador de COVs, Lluvia ácida
III	Majadahonda	SO <sub>2</sub> , NO <sub>x</sub> , Partículas PM <sub>10</sub> , CB (U <sub>A</sub> ), CO y meteorología
III	Colmenar Viejo	NO <sub>x</sub> , Partículas PM <sub>10</sub> , CB (U <sub>A</sub> ) y meteorología
III	Chapinería	NO <sub>x</sub> , Partículas PM <sub>10</sub> , CB (U <sub>A</sub> ) y meteorología
III	Aranjuez	NO <sub>x</sub> , Partículas PM <sub>10</sub> , CB (U <sub>A</sub> ) y meteorología
III	Guadarrama	CB (U <sub>A</sub> )
III	San Martín de Valdeig.	CB (U <sub>A</sub> )
III	Laguna del Campillo (Rivas-Vaciamadrid)	CB (U <sub>A</sub> )
III	Buitrago de Lozoya	CB (U <sub>A</sub> )

- ▲ Estaciones "completas"
- ▲ Estaciones sólo de ozono



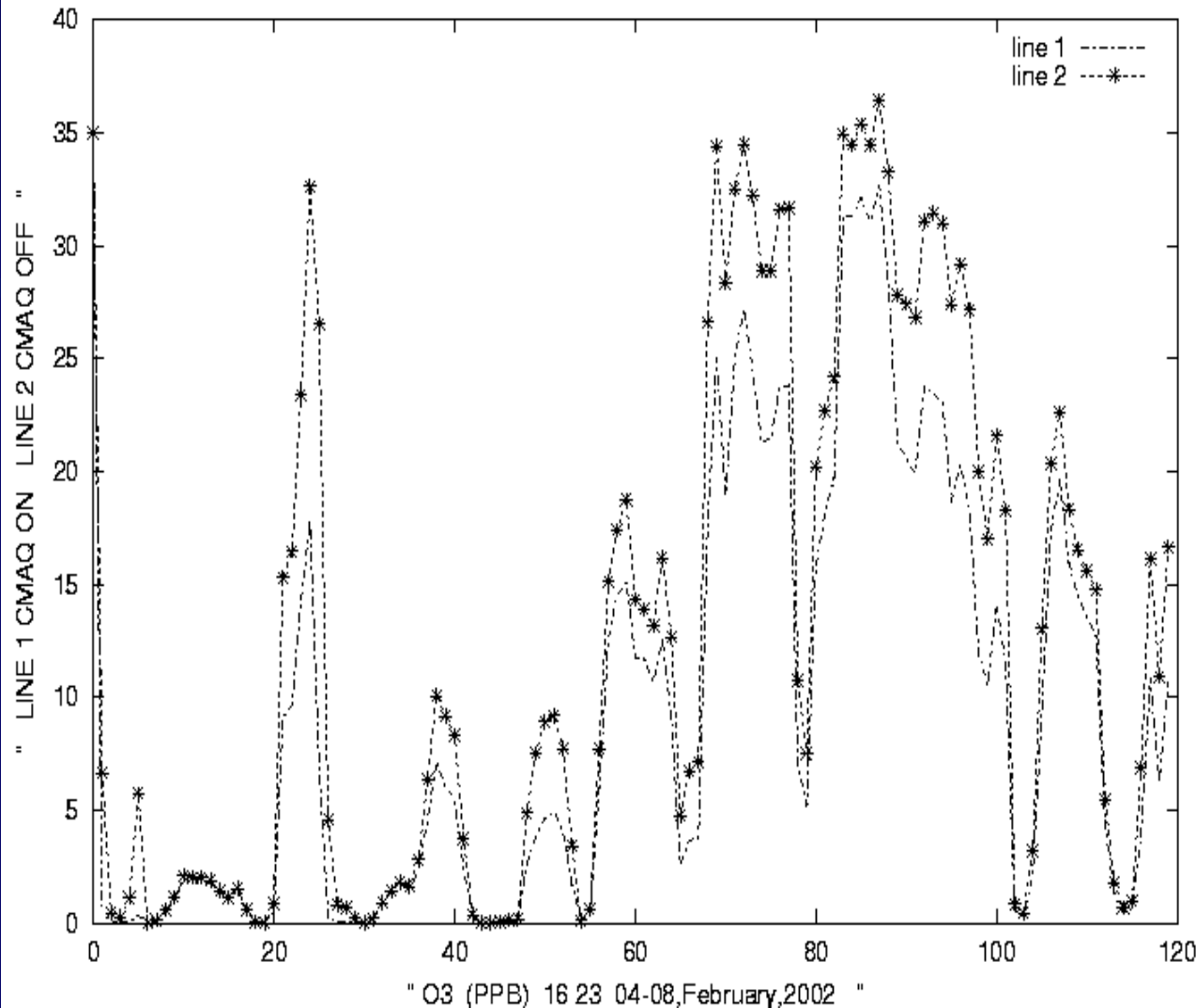
Environmental Software and Modelling  
Group <http://artico.lma.fi.upm.es>



**upm**

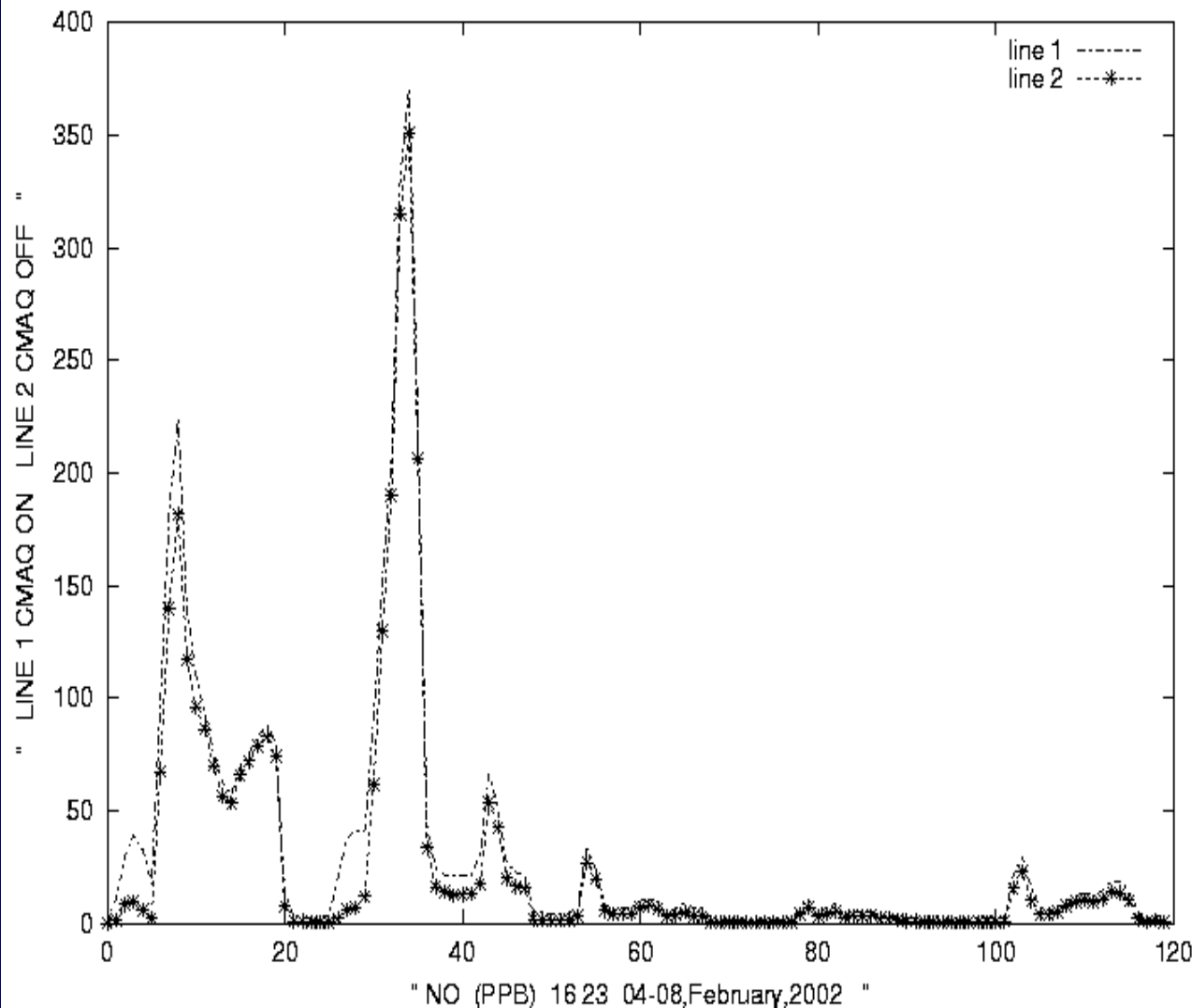
UNIVERSIDAD POLITÉCNICA DE MADRID





**MM5-CMAQ  
Ozone  
concentrations  
at industrial  
plant cell  
(3 km) with  
and without  
industrial  
emissions**

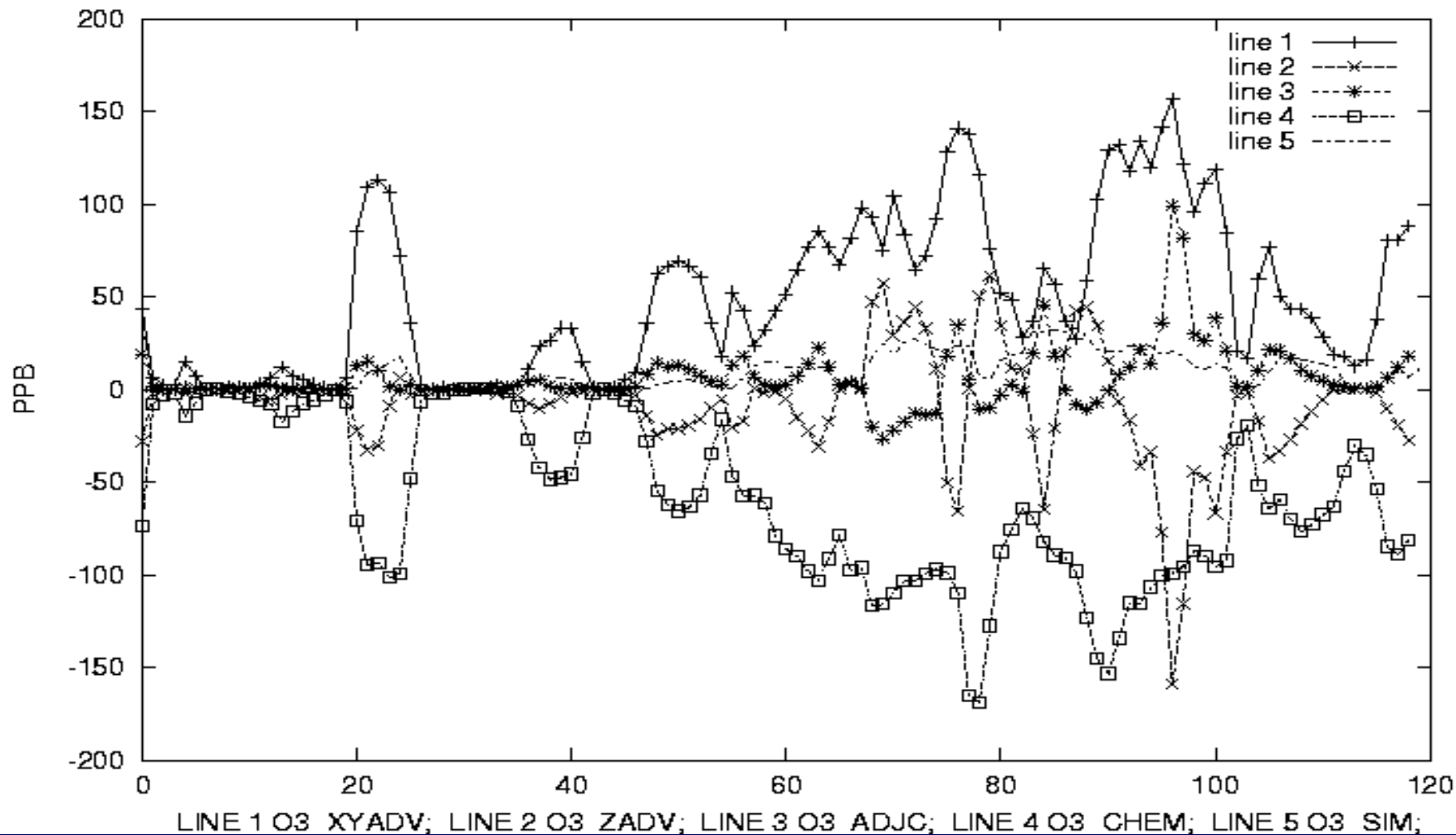




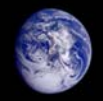
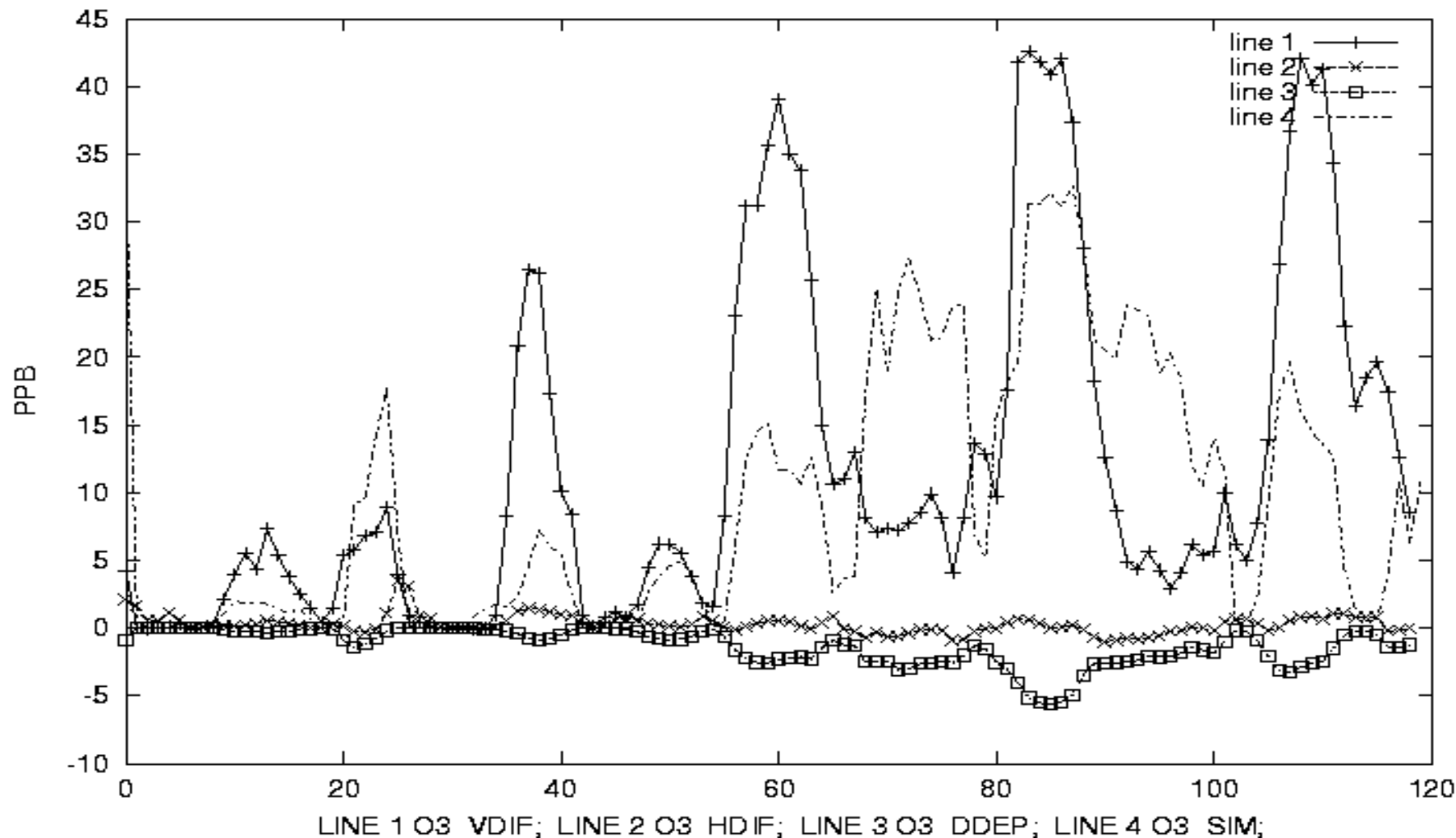
**MM5-CMAQ  
NO  
concentrations  
at industrial  
plant cell  
(3 km) with  
and without  
industrial  
emissions**



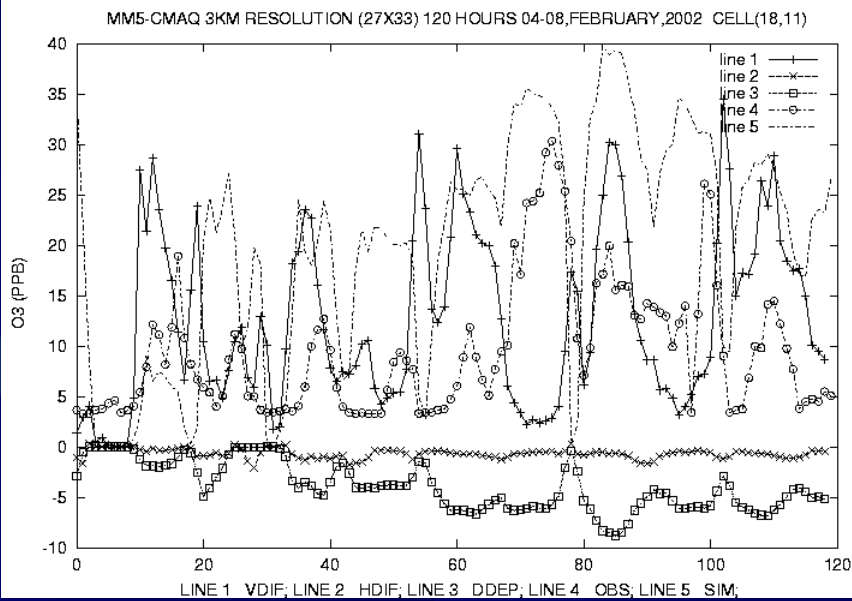
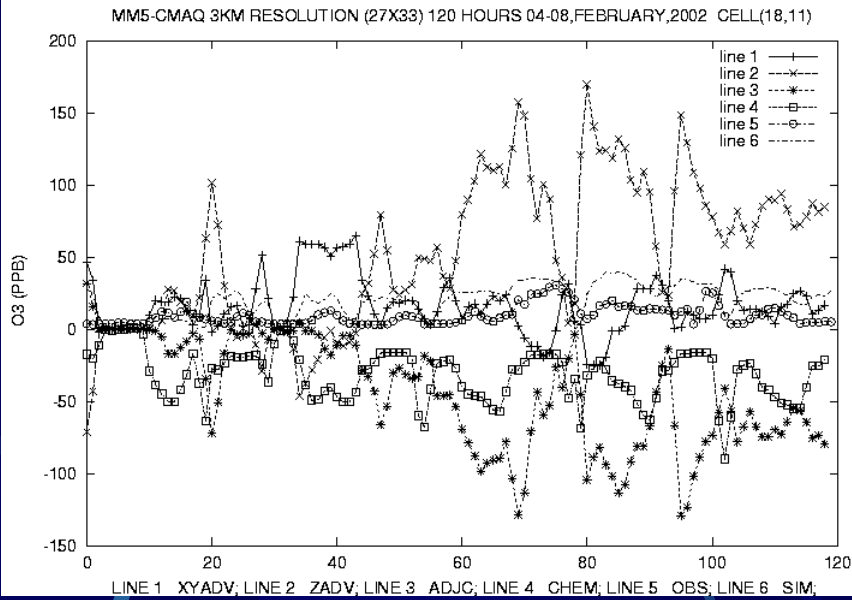
MM5-CMAQ 3KM RESOLUTION (27X33) 120 HOURS 04-08, FEBRUARY, 2002 CELL(16,23)



MM5-CMAQ 3KM RESOLUTION (27X33) 120 HOURS 04-08, FEBRUARY, 2002 CELL(16,23)

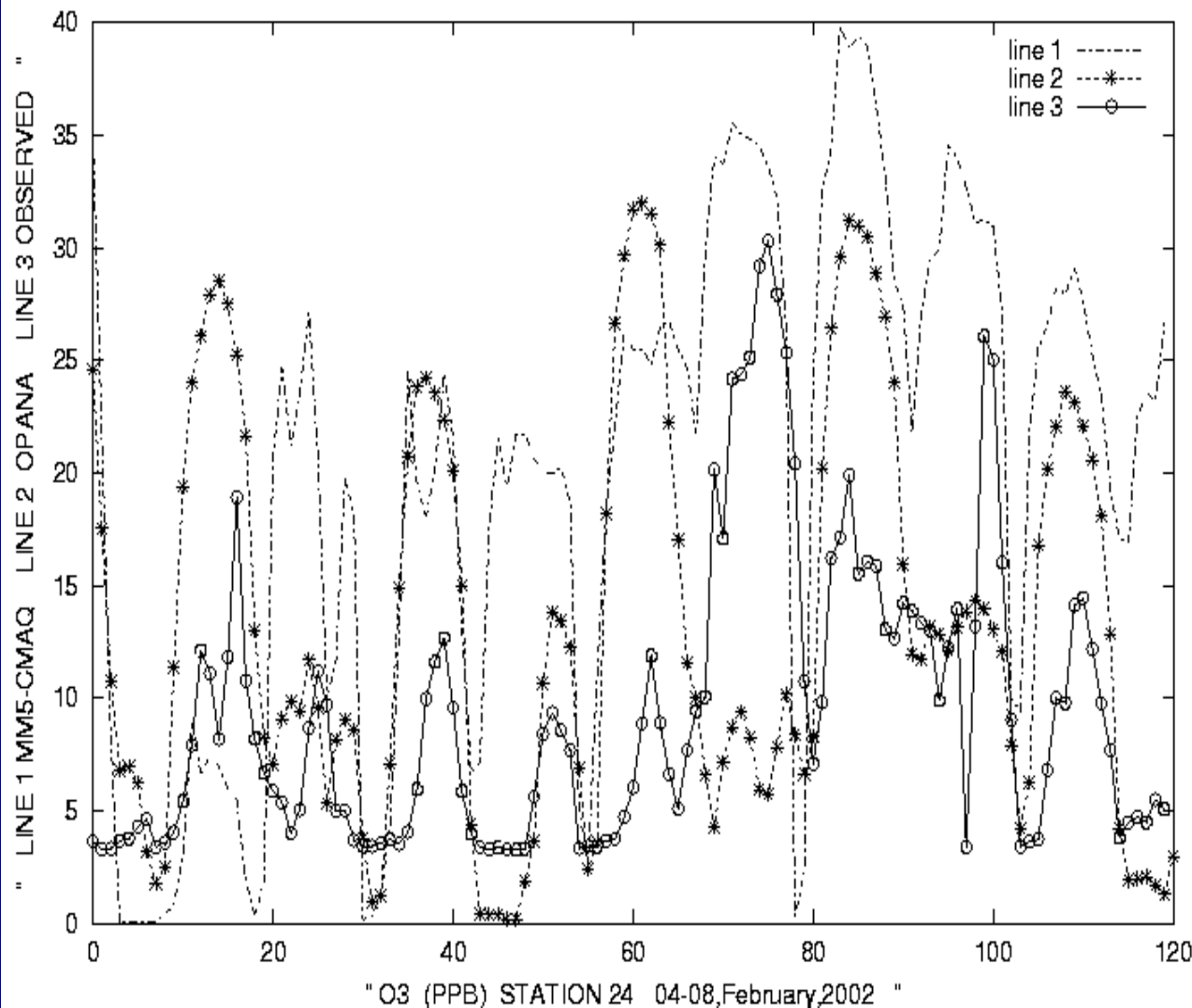


# MM5-CMAQ PROCESS ANALYSIS



Casa de Campo automatic air quality monitoring station





**OPANA,  
MM5-CMAQ  
and  
observed  
Ozone  
concentrations  
at Casa de  
Campo  
monitoring  
station**

