Map3D

Forecasting Air Quality

Map3D

"Mesoscale Air Pollution 3D modeling"

http://map3d.inoe.ro

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Regional Air Pollution Processes

COMPLEX

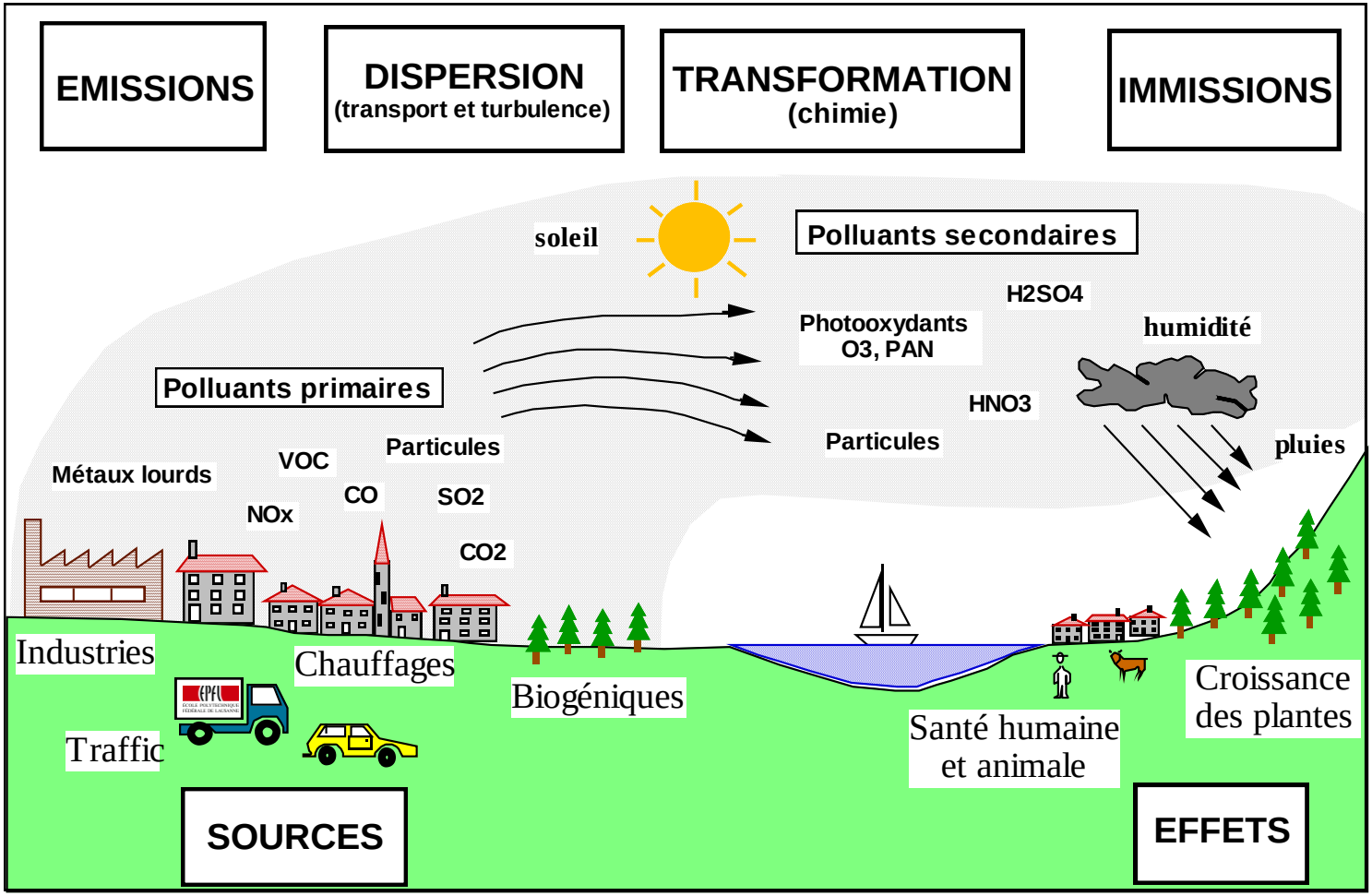
TRANSPORT

CHEMISTRY

OZONE

METEO

EFFECTS



Classical Analytical Techniques

3D MODEL

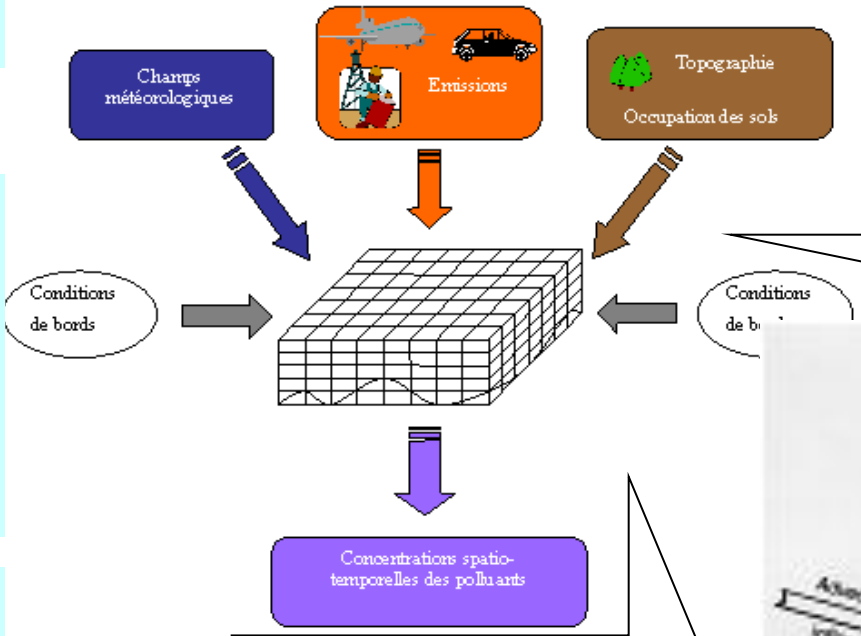
METEO

EMISIONS

TOPO

LIMIT Conditions

Meteo & Pollution f (time, space)



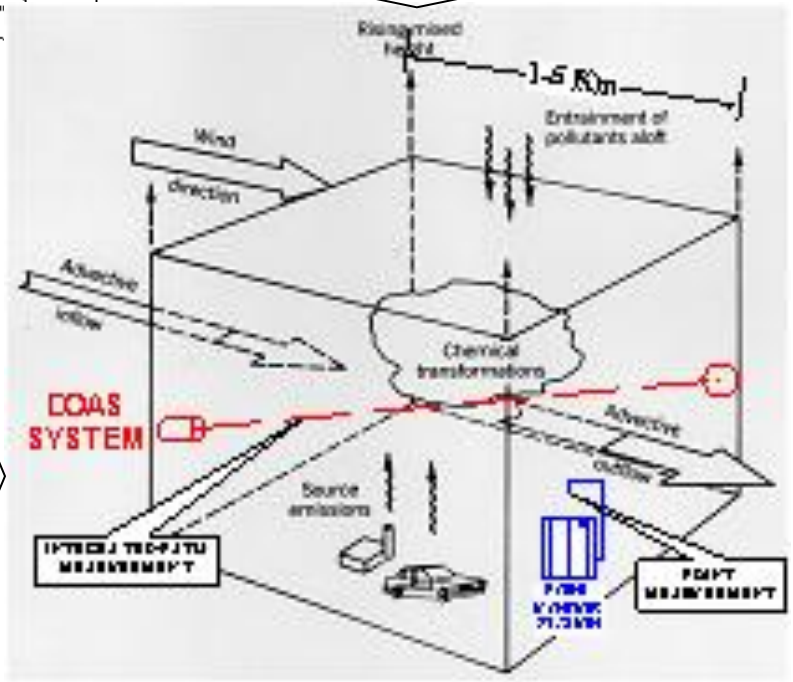
DOAS

LIDAR,

WindProfiler,

RadioSounding

Need of 3D Representative Measurements

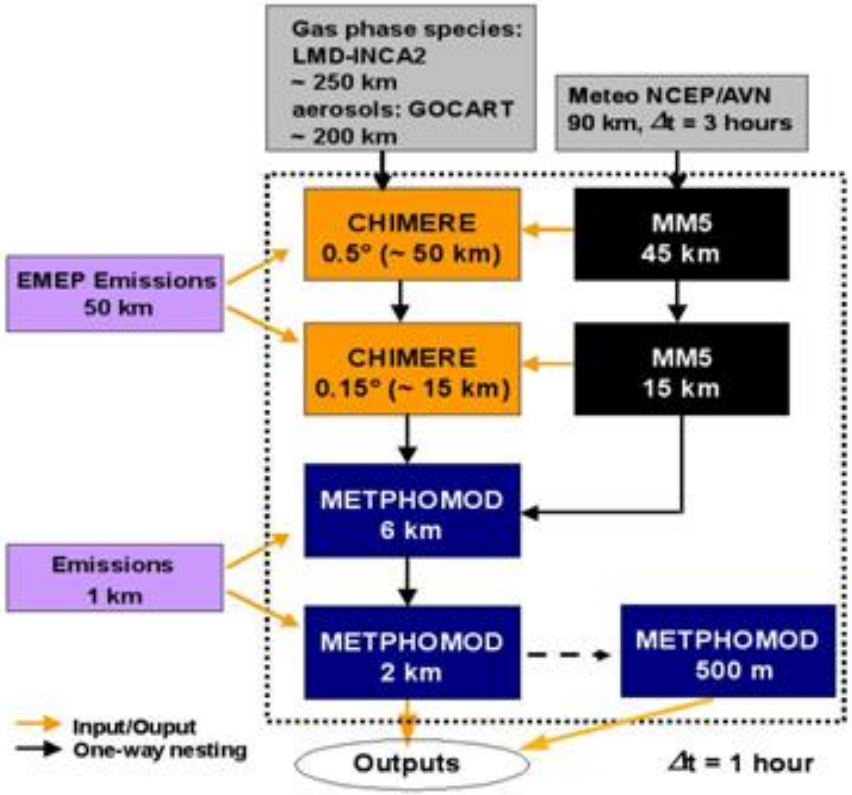


Outline

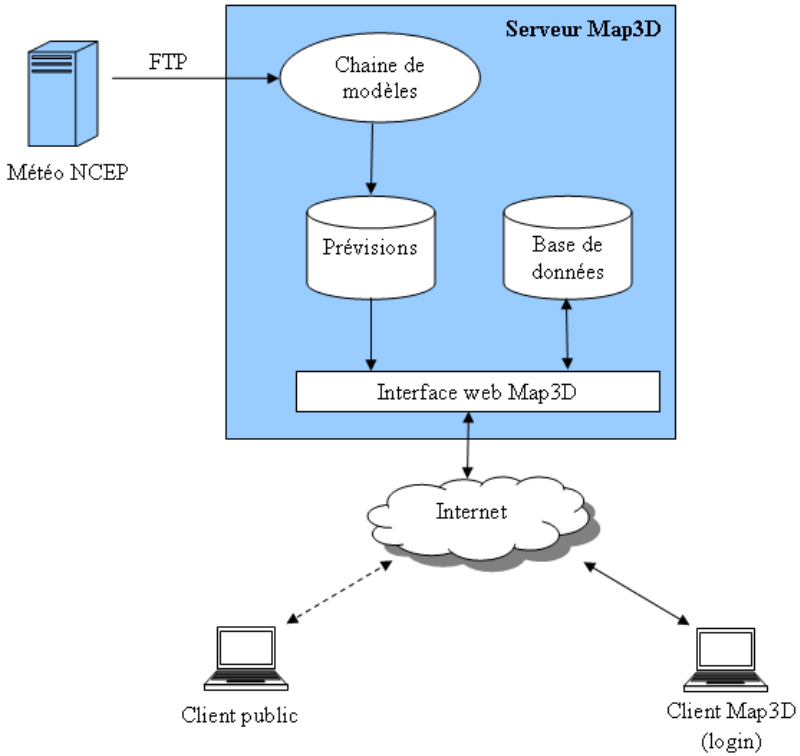
- Experience of air quality studies and Innogrants awards
- Description of the modelling chain
- **MAP3D** outputs and web interface
- Model results validation for the period of August 2008 - February 2009 for O_3, O_x and PM_{10}
- Discussion and perspectives

Technical solution

Model Chain Set up

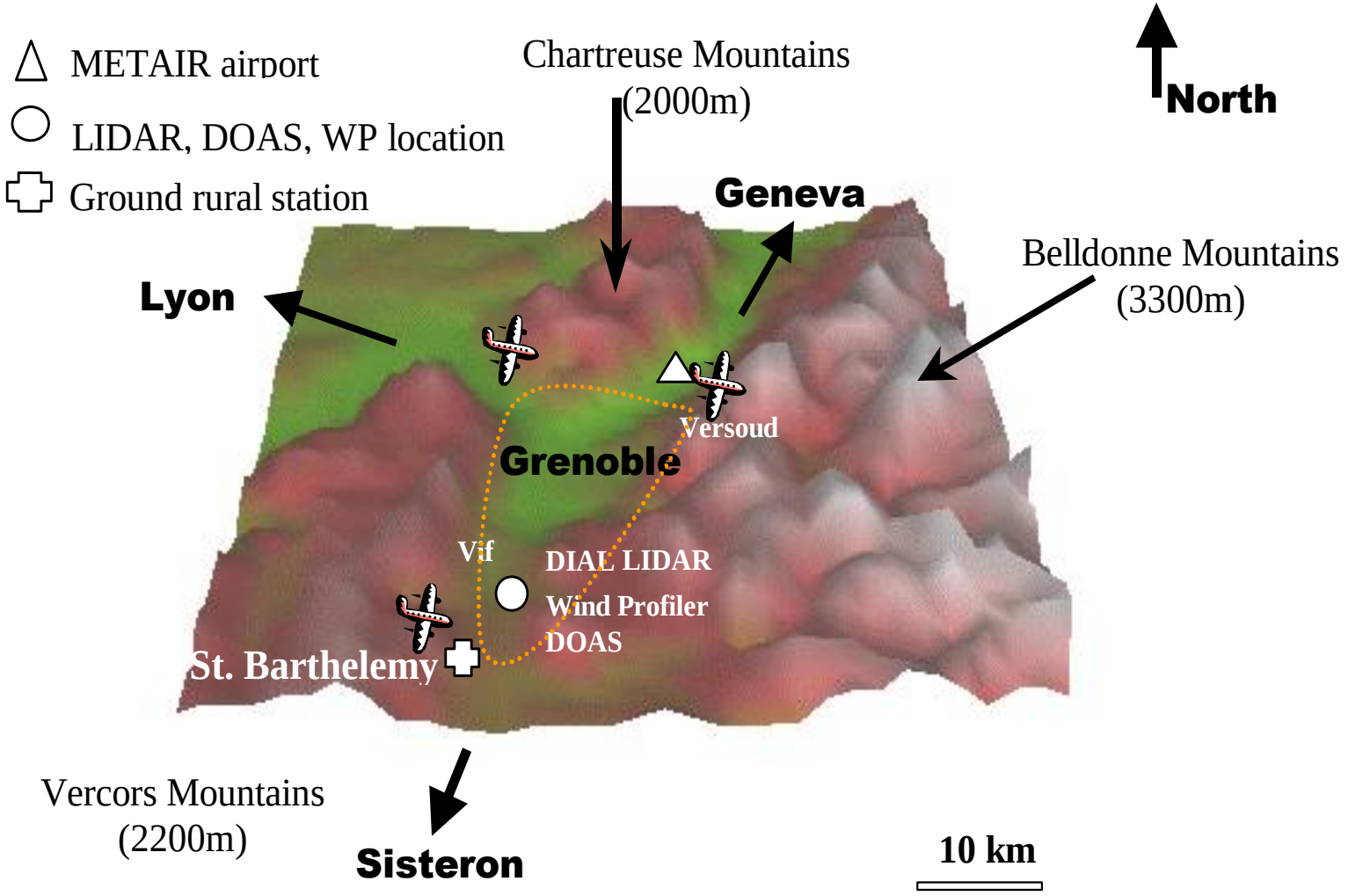


Computer Architecture



Map3D server :
Dell PowerEdge 2950 with Intel Quad-Core Xeon 2,33GHz/2x4MB

- Complex Topography
- 3 D Monitoring
- 3 D Modeling
- Inter Validation
- Complex Chemistry



Validation Comparisons

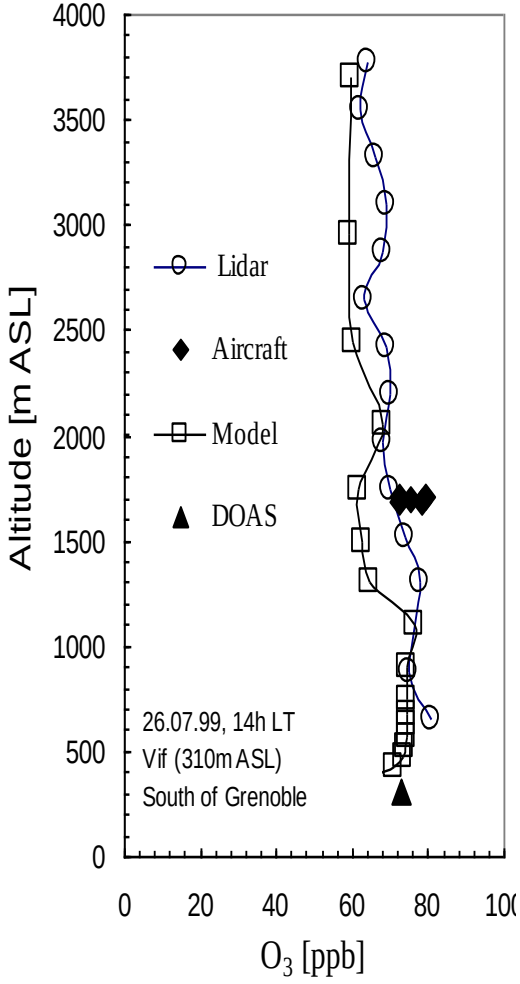
Complement WindProfiler

Complement DOAS

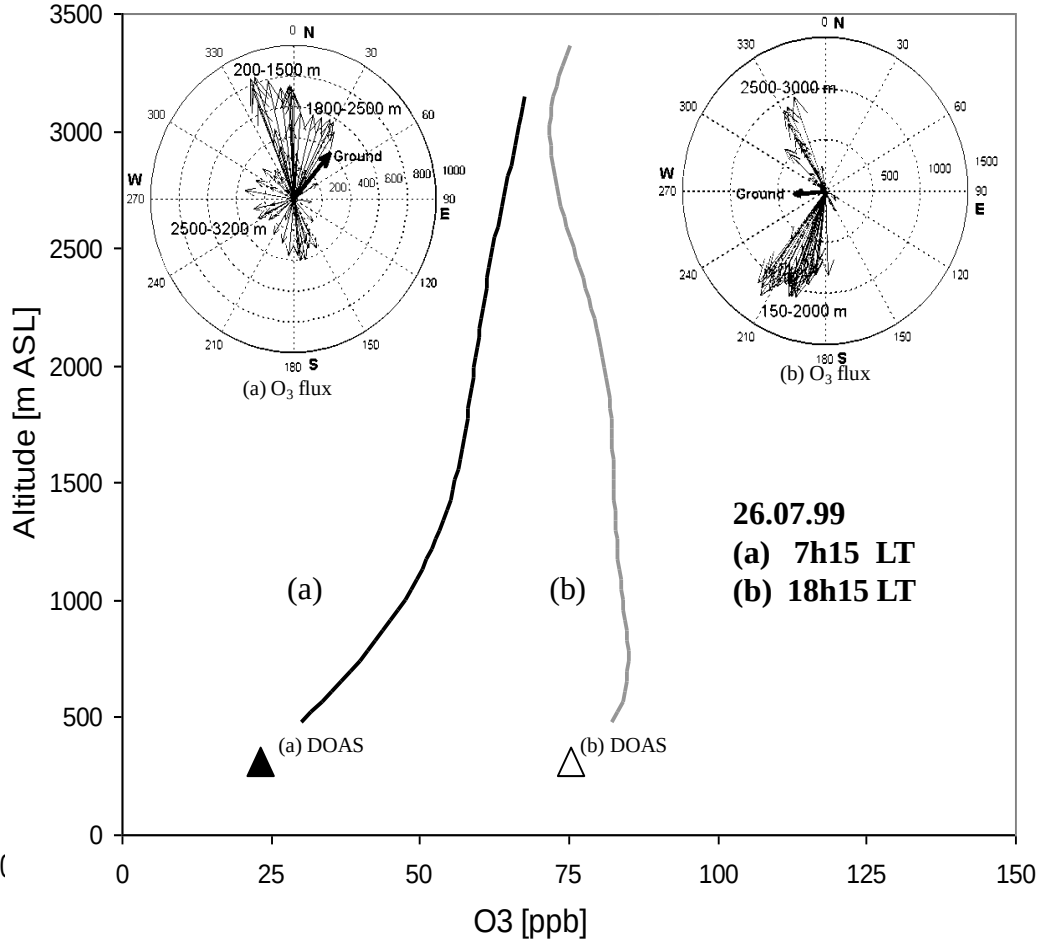
Complement AirCraft

Complement MODEL

OZONE : Profiles

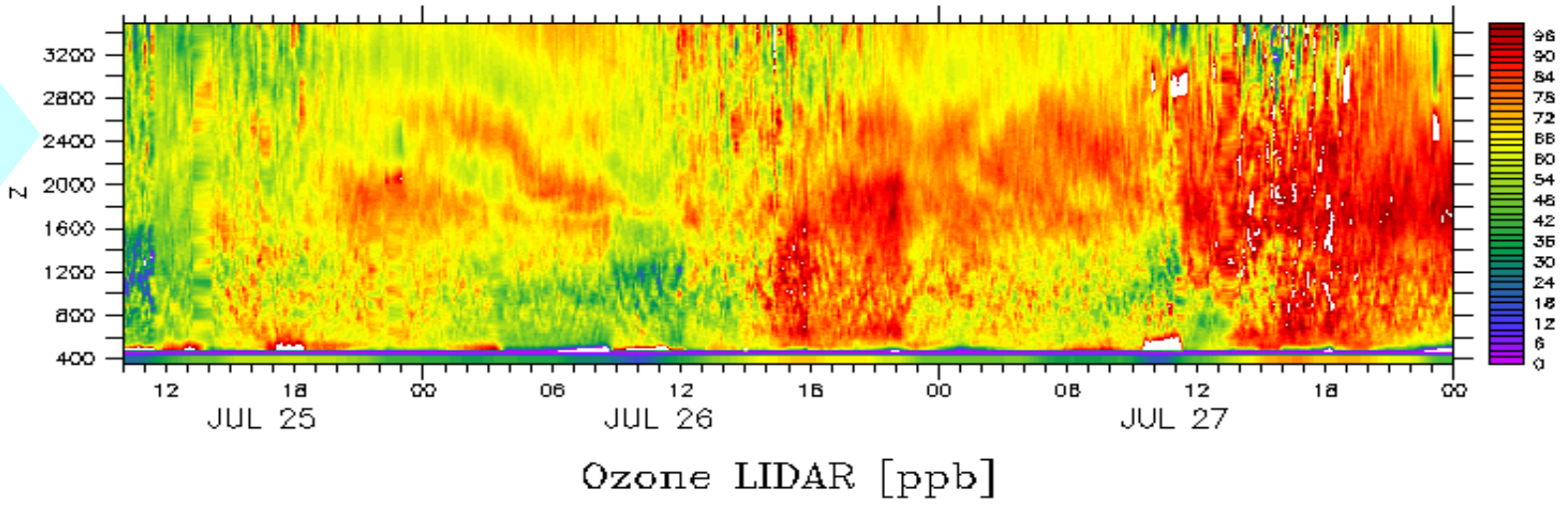


Fluxes

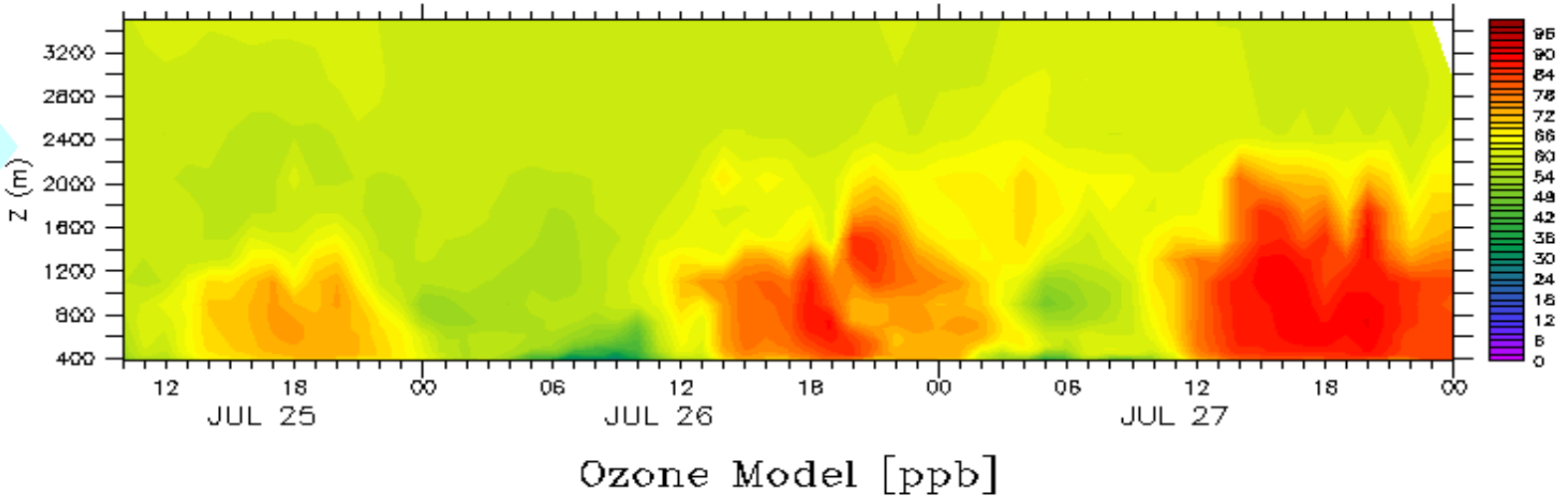


3D - OZONE: LIDAR & MODEL

LIDAR



MODEL



Long experience of air quality studies in several European regions

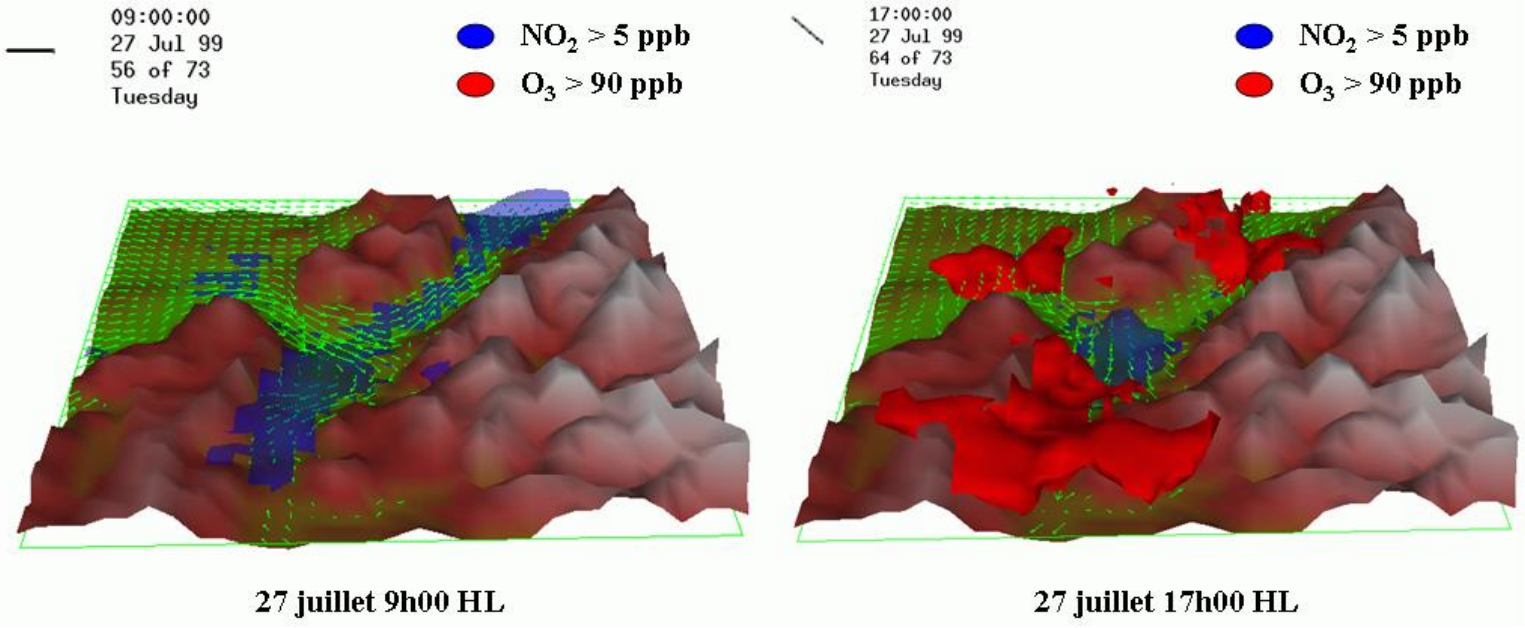
Different case studies

- City of Grenoble in complex terrain
- Strasbourg area
- City of Geneva
- Greater Madrid area
- Greater Athens area

Model development

- Metphomod
- Model chain
- Chemical mechanism RACM
- Chemeta
- Air pollution indicators

Grenoble Case 3D simulations O_3, NO_2 and wind



Our use of CHIMERE

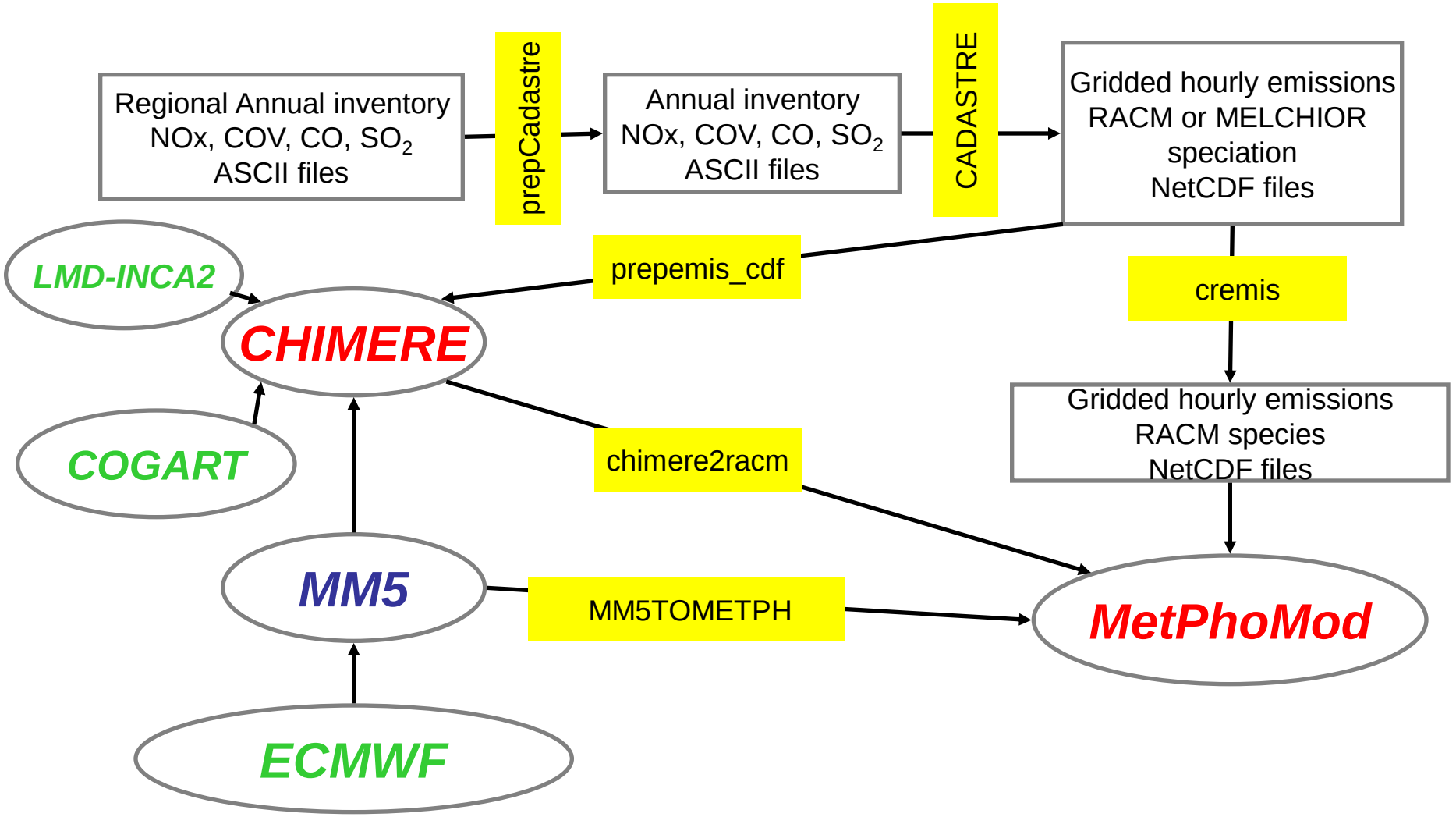
• CHIMERE is used at boundaries of our model MetPhoMod

• Since CHIMERE has never been validated in very complex terrain our use of the model is limited to regional scales:

- Continental for calculate background concentration in the Alps

- Regional to account for main cities (Lyon, Geneva, Marseille, Torino) contributing to regional ozone

Technical schematic of the chain



Use of CHIMERE to constraint a fine scale model : MetPhoMod

- Problems and questions:
  - How evaluate the quality of forcing by MM5 and CHIMERE ?
  - Model have different horizontal meshes
    Lambert, dx = 6 km/ Lambert 2 Etendu, dx = 2 km
  - Model have different vertical descriptions
    8 hybrid sigma levels/ 24 cartesian levels
  - Models have different chemical mechanisms
    MELCHIOR/ RACM

- Solutions:
  - Perform comparison with 3D and ground data
  - Perform horizontal interpolation
  - Perform vertical interpolation
  - Using only common species to both mechanisms

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Correspondance between MELCHIOR and RACM

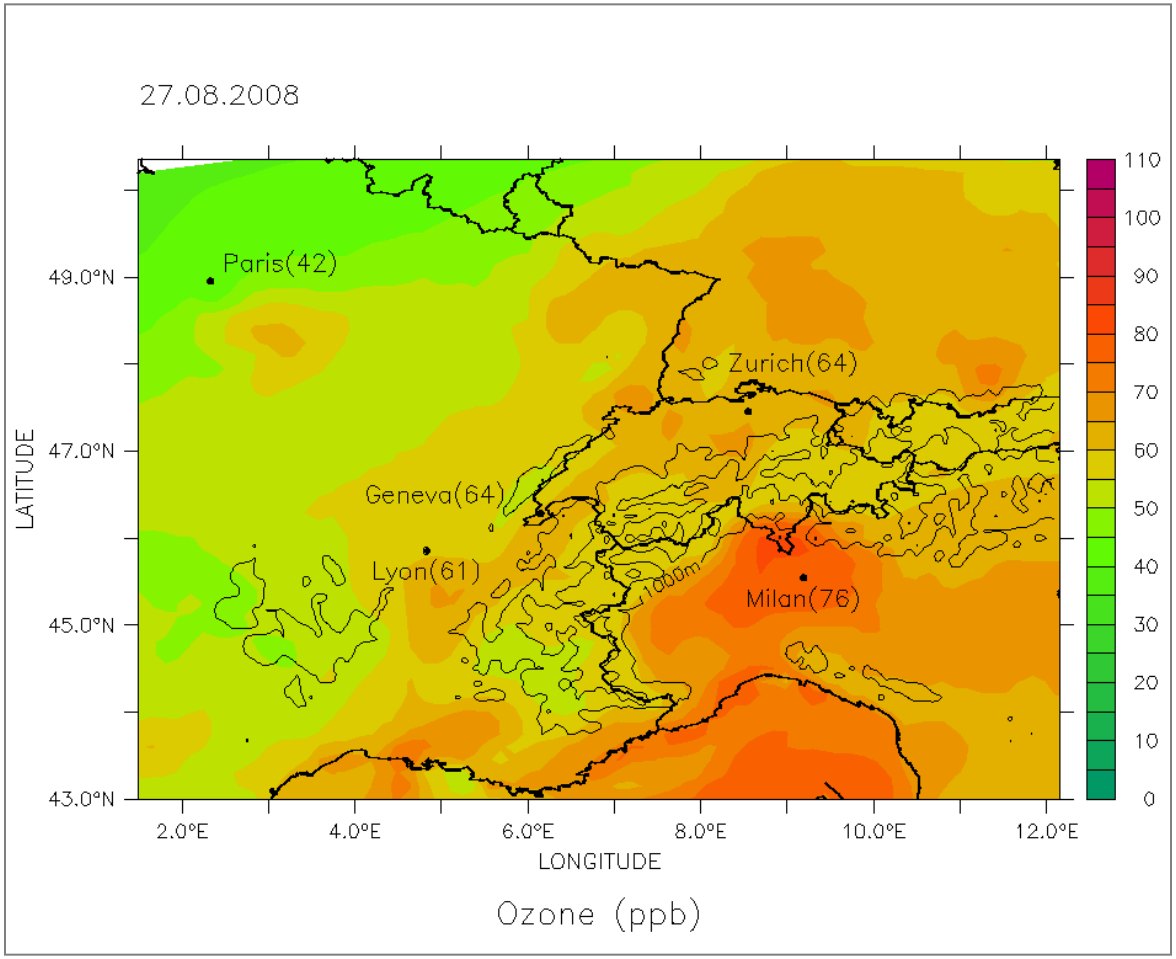
Nom MELCHIOR	Description MELCHIOR	Nom RACM	Description RACM
O_3	ozone	O_3	ozone
NO_2	nitrogen dioxide	NO_2	nitrogen dioxide
NO	nitric oxide	NO	nitric oxide
PAN	peroxyacetyl nitrate	PAN	peroxyacetyl nitrate ans higher saturated PANs
HNO_3	nitric acid	HNO_3	nitric acid
SO_2	sulfur dioxide	SO2	sulfur dioxide
CO	carbon monoxide	CO	carbon monoxide
CH_4	methane	CH4	methane
C_2H_6	ethane	ETH	ethane
NC_4H_{10}	n-butane	HC5	alkanes, alcohols, esters and alkynes with HO rate between $3.4*10^{-12}$ and $6.8*10^{-12}$ cm^3 s^{-1}
C_2H_4	ethene	ETE	ethene
C3H6	propene	OLT	terminal alkenes
OXYL	o-xylene	TOL	toluene and less reactive aromatics
C_5H_8	isoprene	ISO	isoprene
APINEN	α [illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

20 species from CHIMERE are related to RACM species

Table : correspondance between MELCHIOR and RACM species

Map3D outputs and web interface

Ozone concentration [ppb] with 15 km resolution for Switzerland



Access to the forecast results and to a personalized web interface via login

- three days weather and air pollution forecast: Hourly concentrations for ozone, PM10, PM2.5 and NO2. Other chemical compounds such as NO, NOx, SO2 or CO can be added to the output.
- access to a database containing all these species. The concentration values can be extracted in text, netCDF or ESRI format
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Ozone simulation and forecast

PM10 simulation and forecast

Map3D

login >

Pollution | Indicateurs | Météo | Extraction | A propos

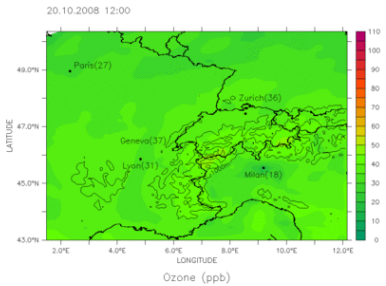
Alpes

Prévisions du 13 novembre 2008

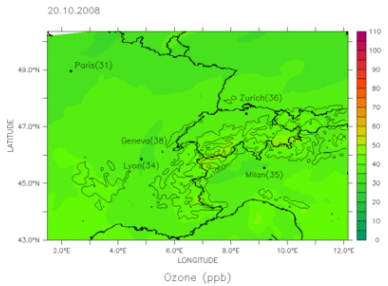
Région: Alpes **Date:** 13.11.2008 **Espèce chimique:** Ozone **Normes:** Europe

Heure

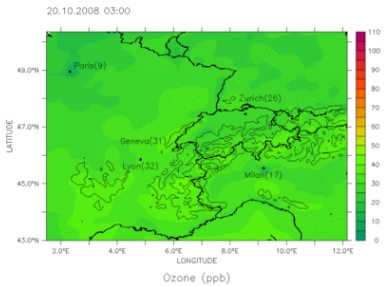
12:00



Maximum journalier



Animation journalière



Moyennes horaires

	Journalier (13.11)			Sur 3 jours (13.11-15.11)			
	min	max	heure	min	max	jour	heure
Ozone [ppb]	0	47	14h	0	47	14.11	4h
NO_2 [ppb]	0	52	20h	0	52	13.11	20h

Moyennes journalières

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PM10 [µg/m³]	2	117	1	117	13.11
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- *Les colonnes "jour" et "heure" indiquent l'heure à laquelle le maximum est atteint.*
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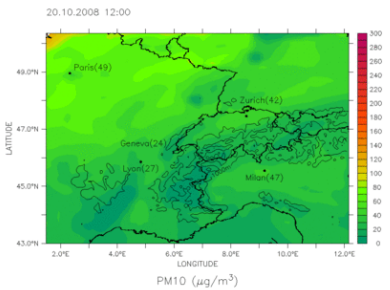

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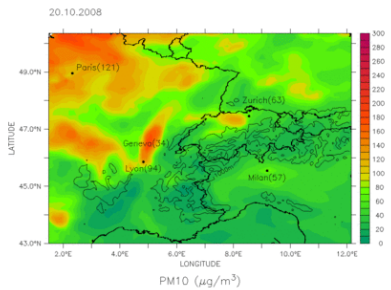
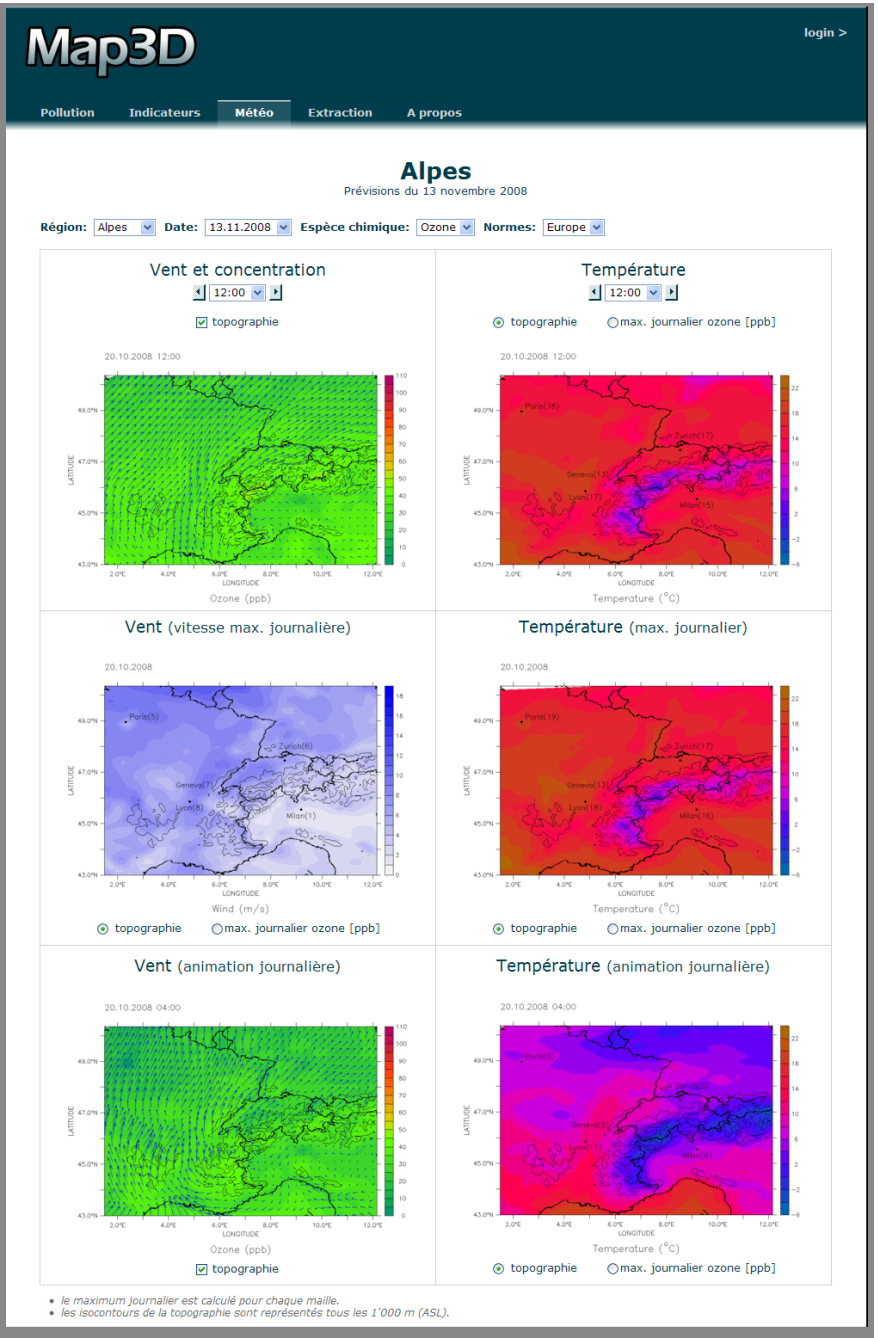
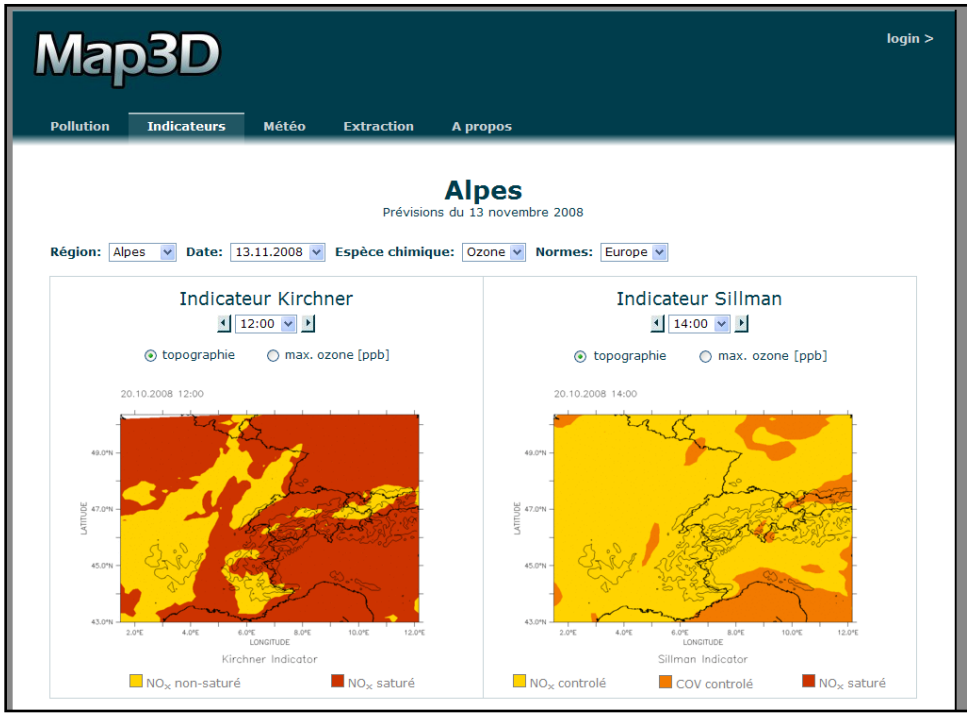


Meteorological fields simulation and forecast



Ozone regimes : Kirchner and Sillman Indicators



http://map3d.epfl.ch

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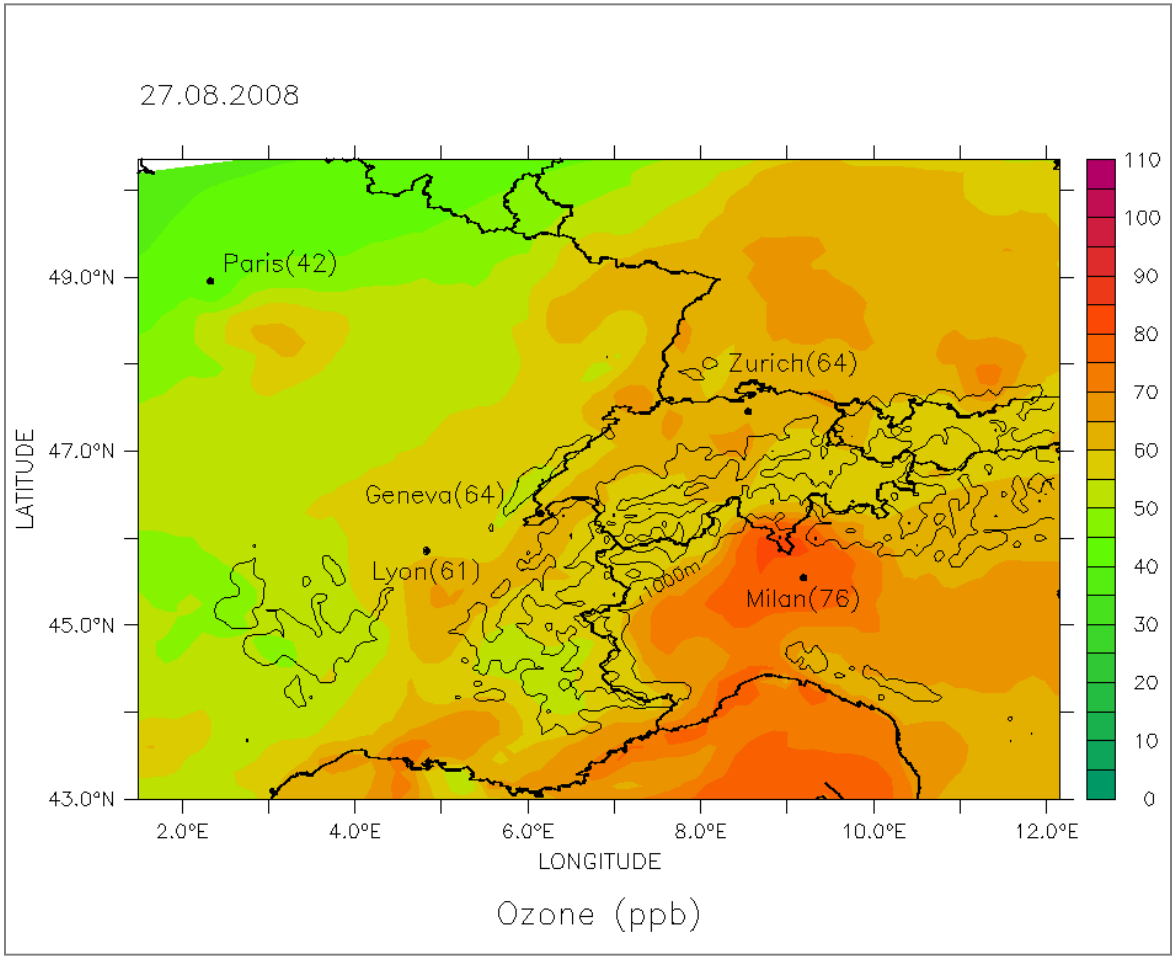

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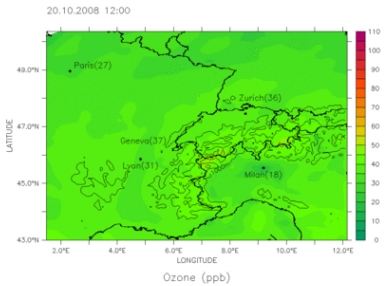

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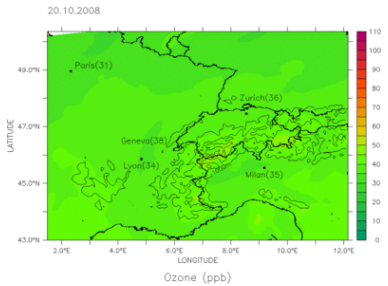

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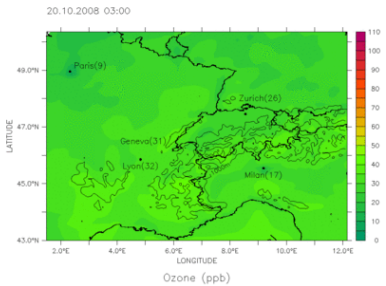

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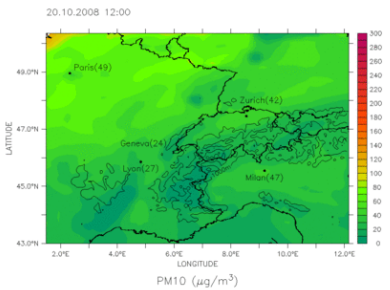

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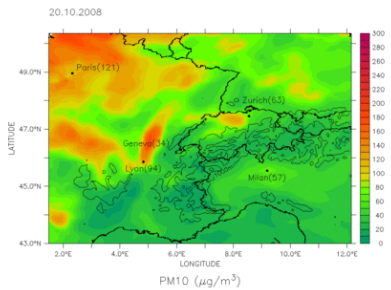

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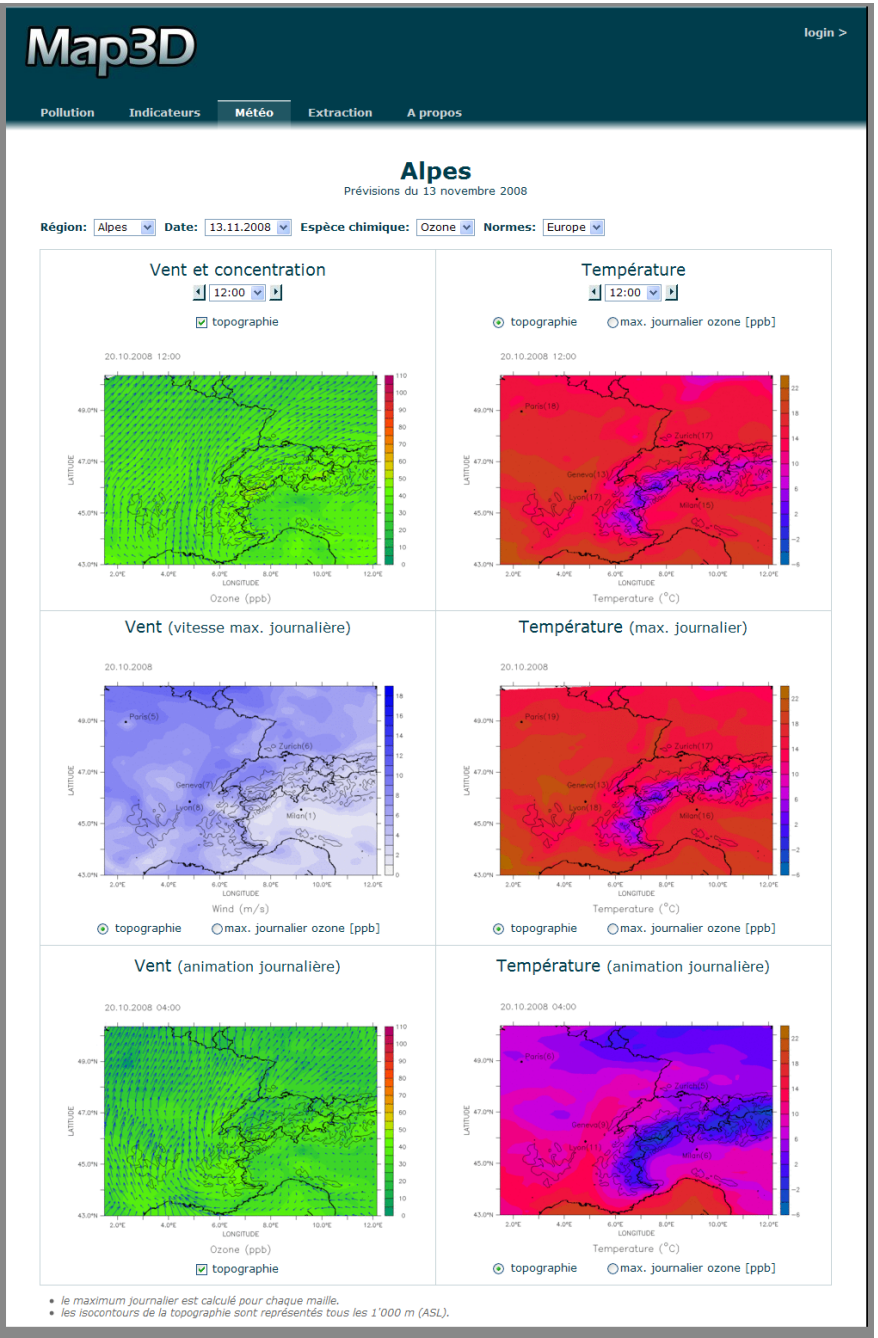

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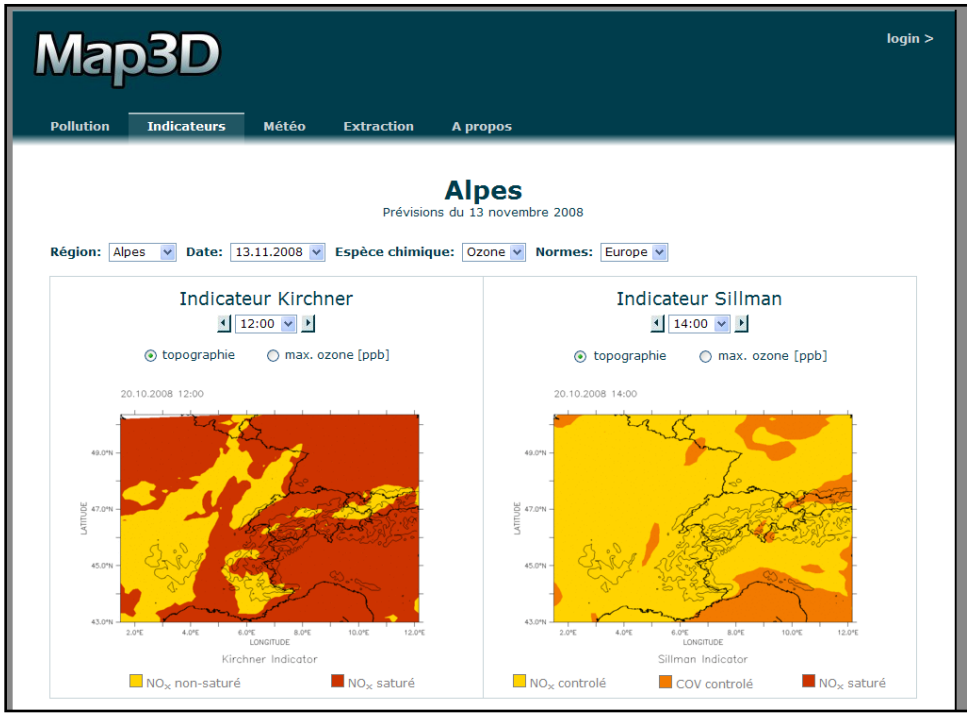

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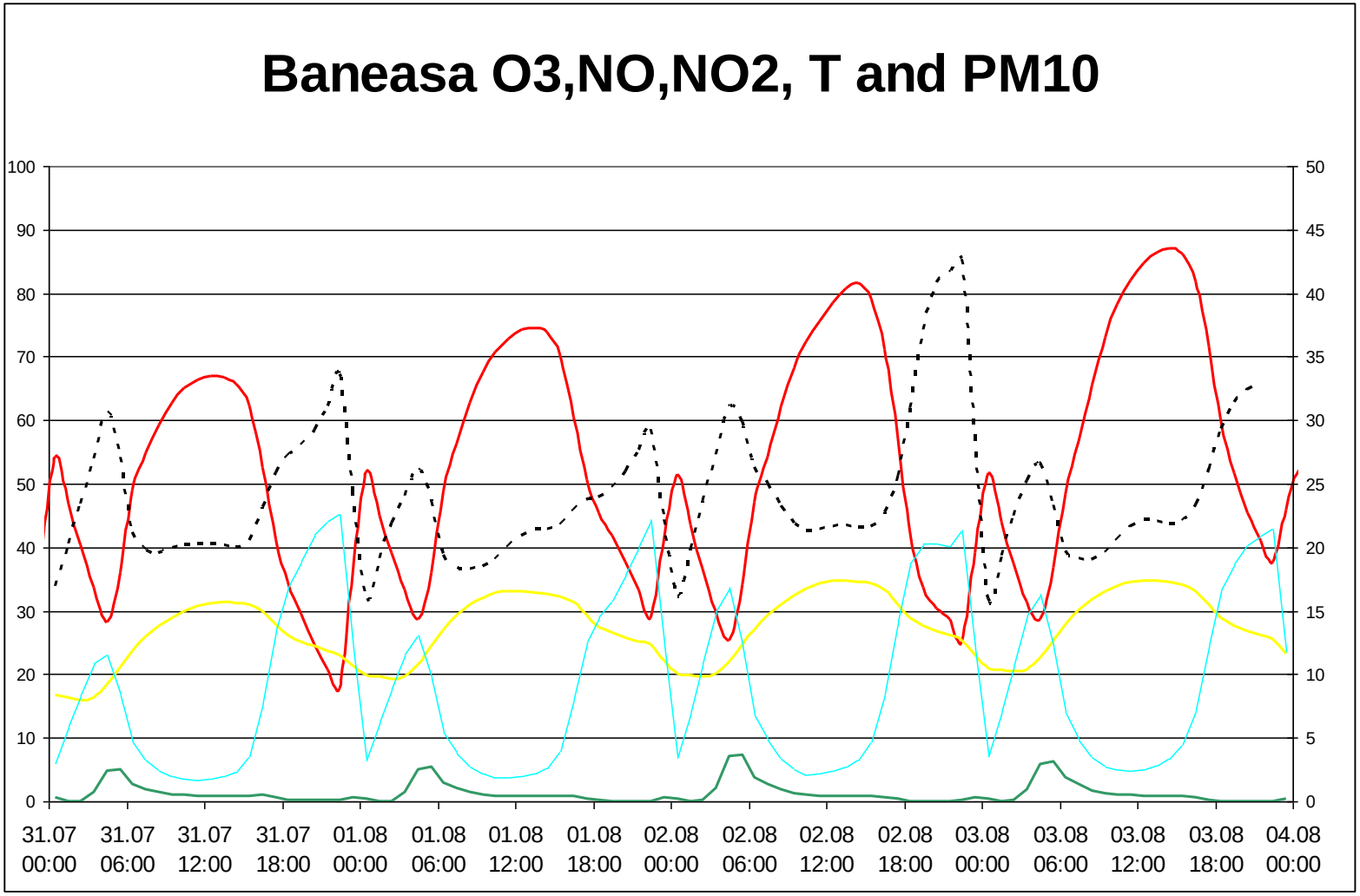
MAP3D Outputs – Overview & First Analysis !?



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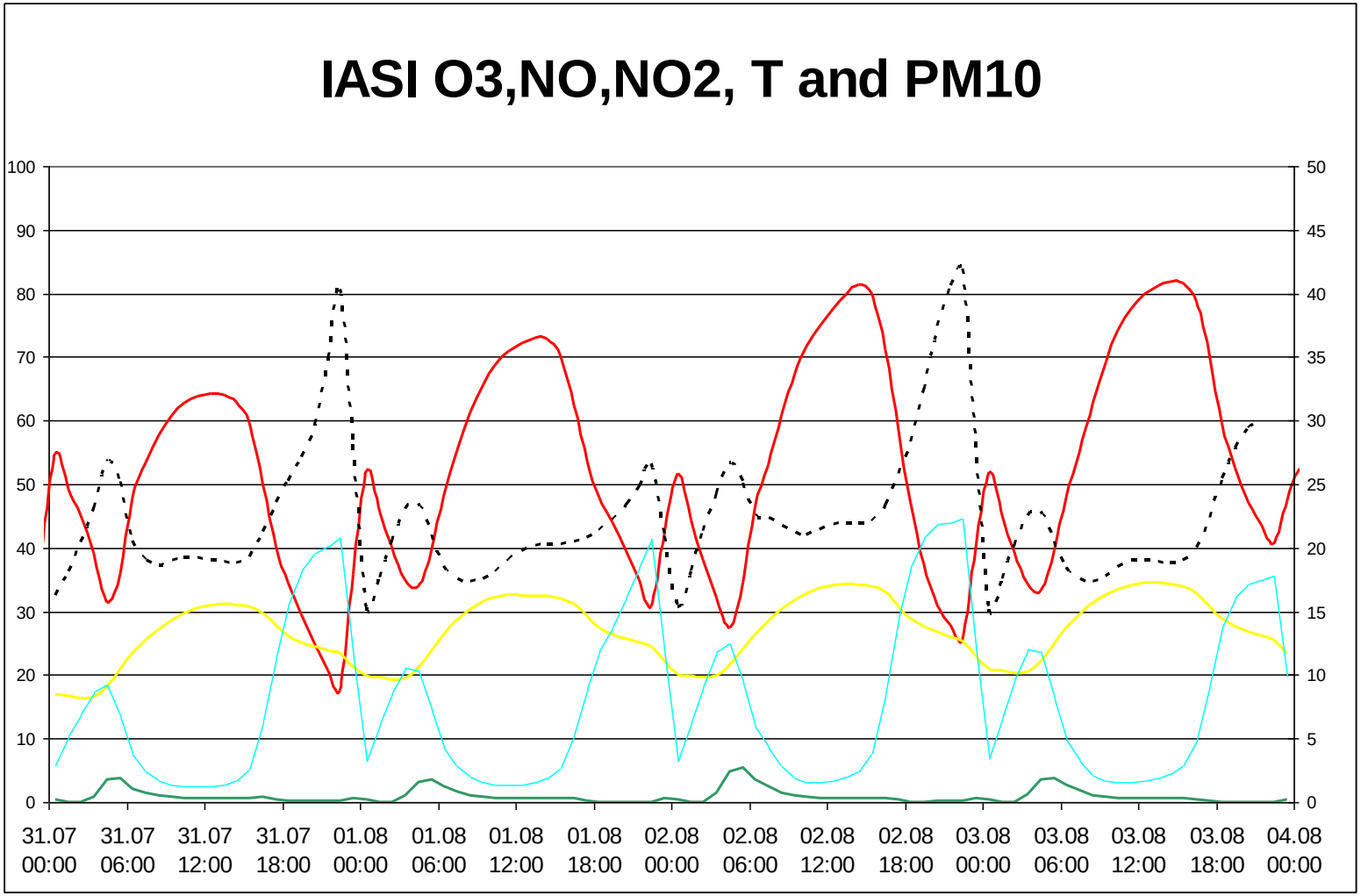

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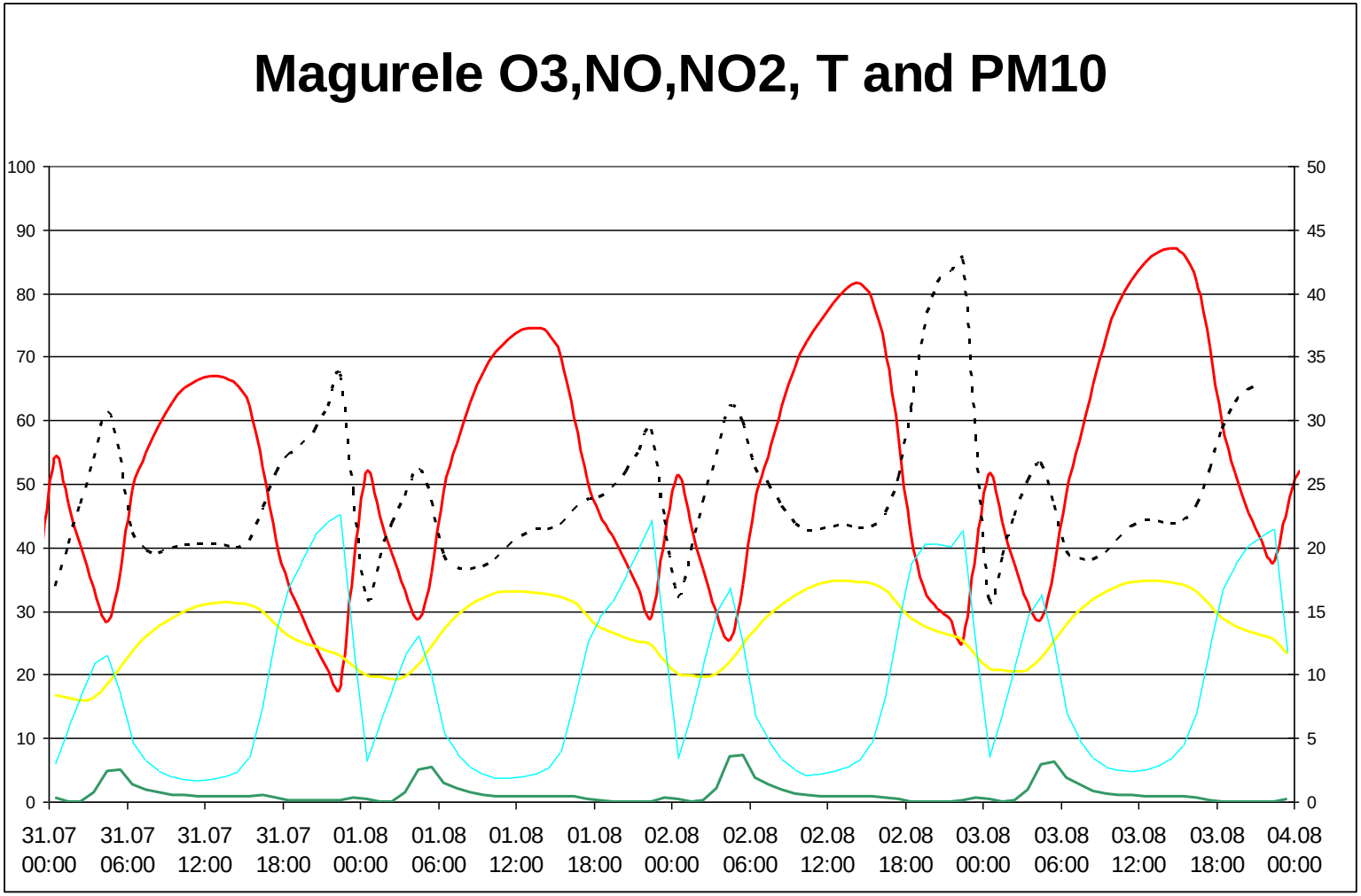

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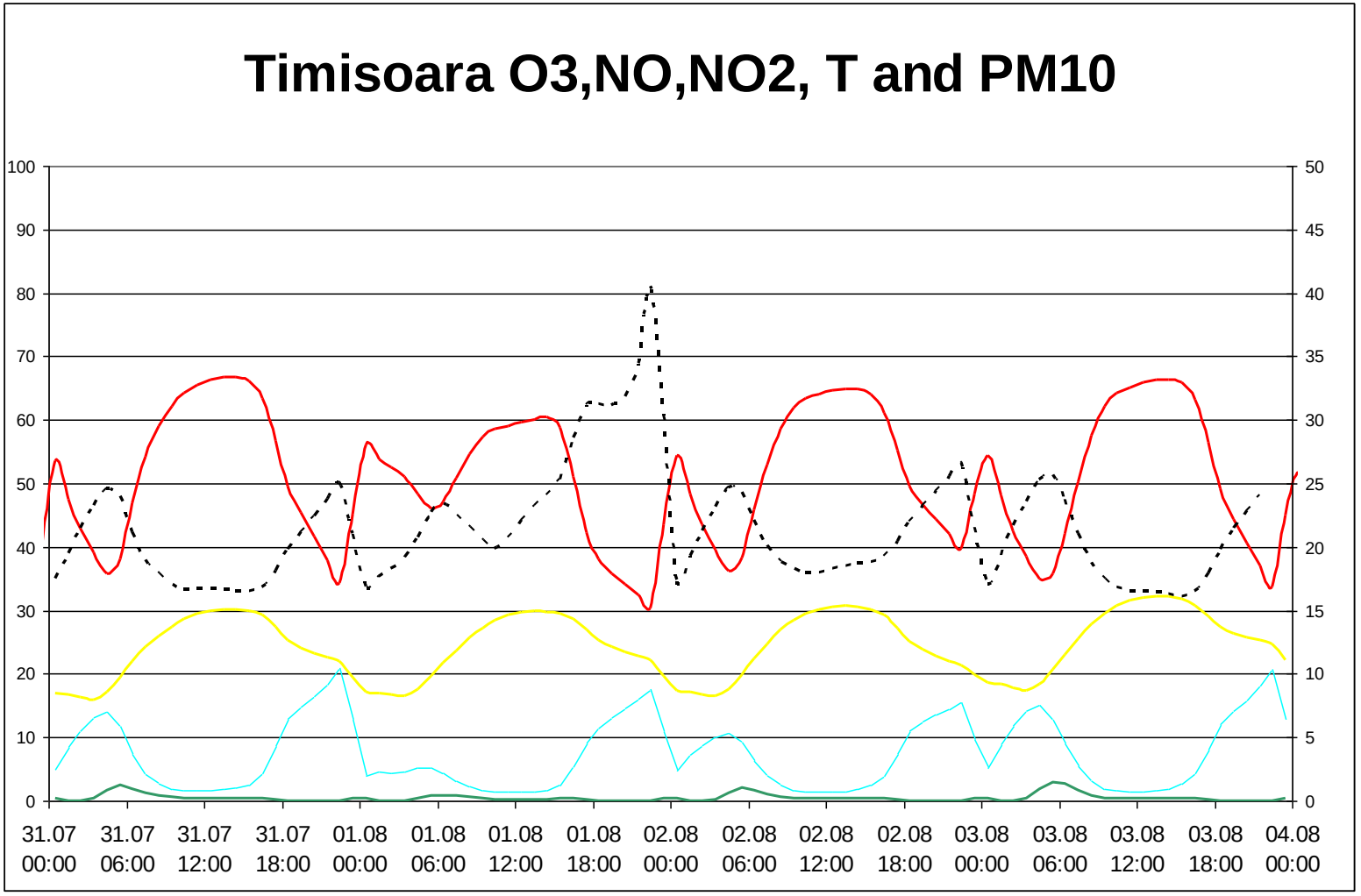

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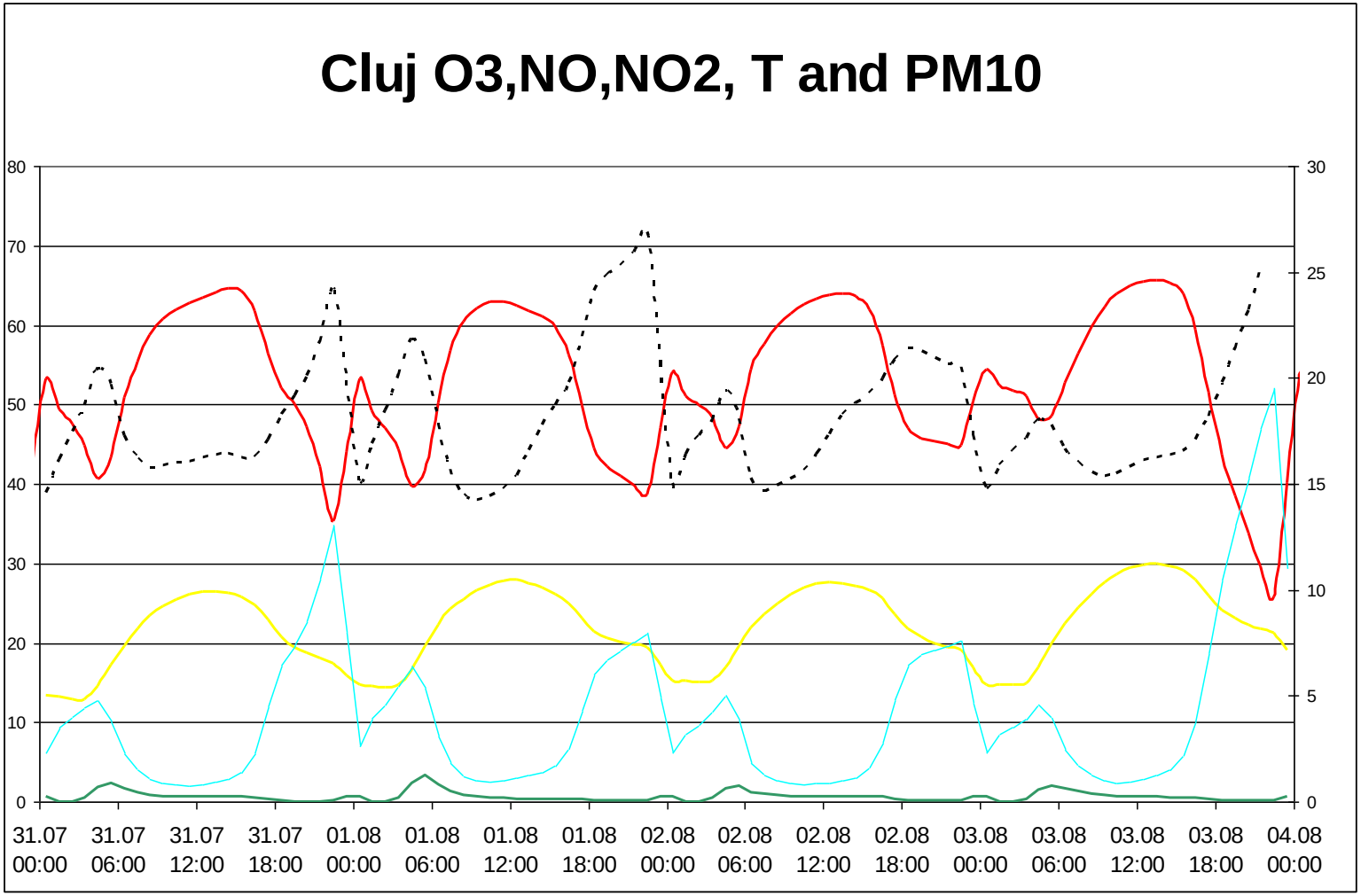
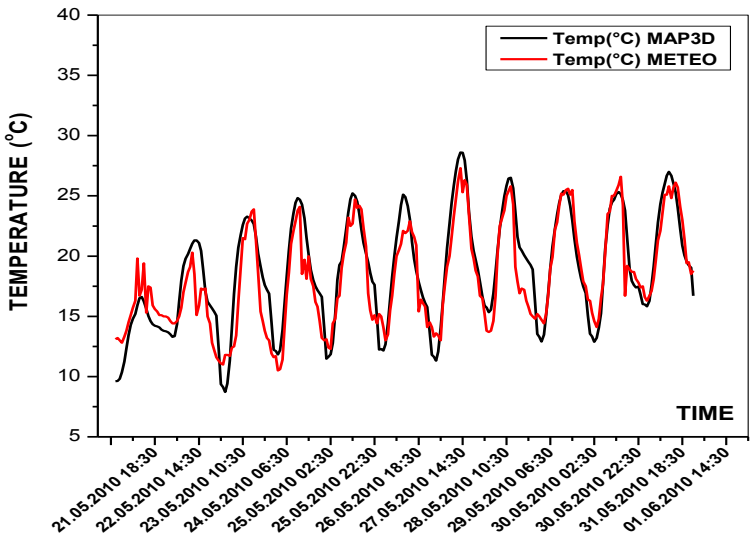
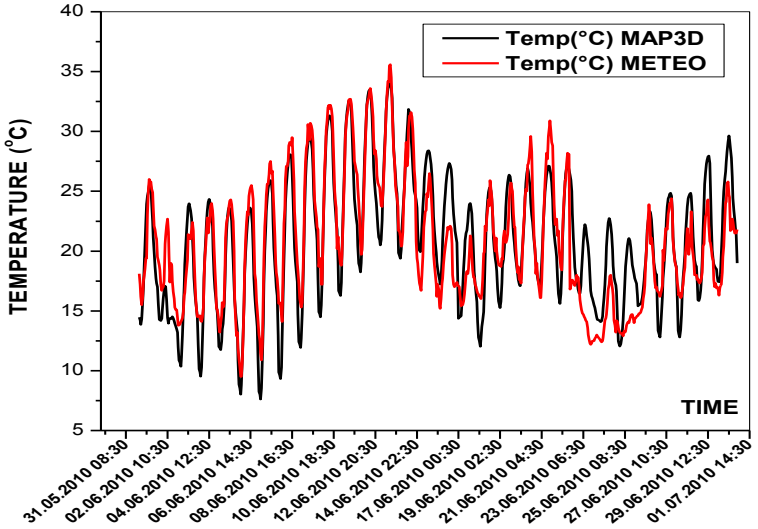


MAP3D Validation ?..... Model Outputs vs Measurements !?





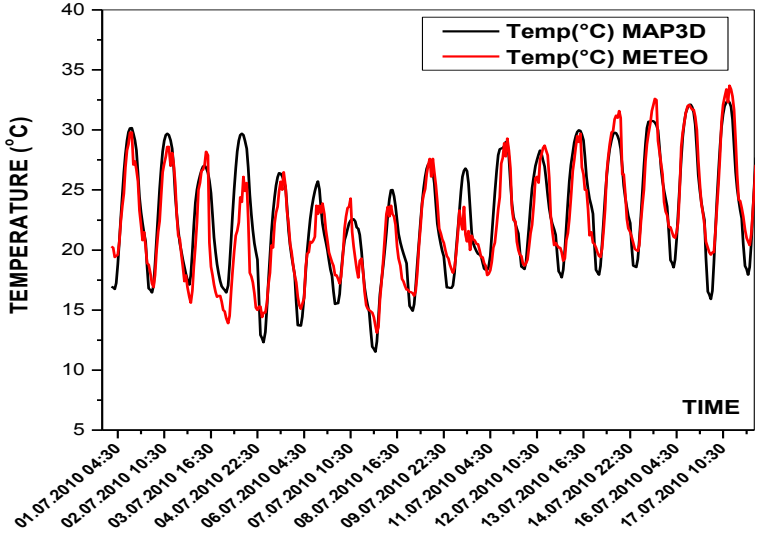


Figure 3.
The temperature temporal profiles: Comparison between meteorological and MAP 3D data at Iasi station.

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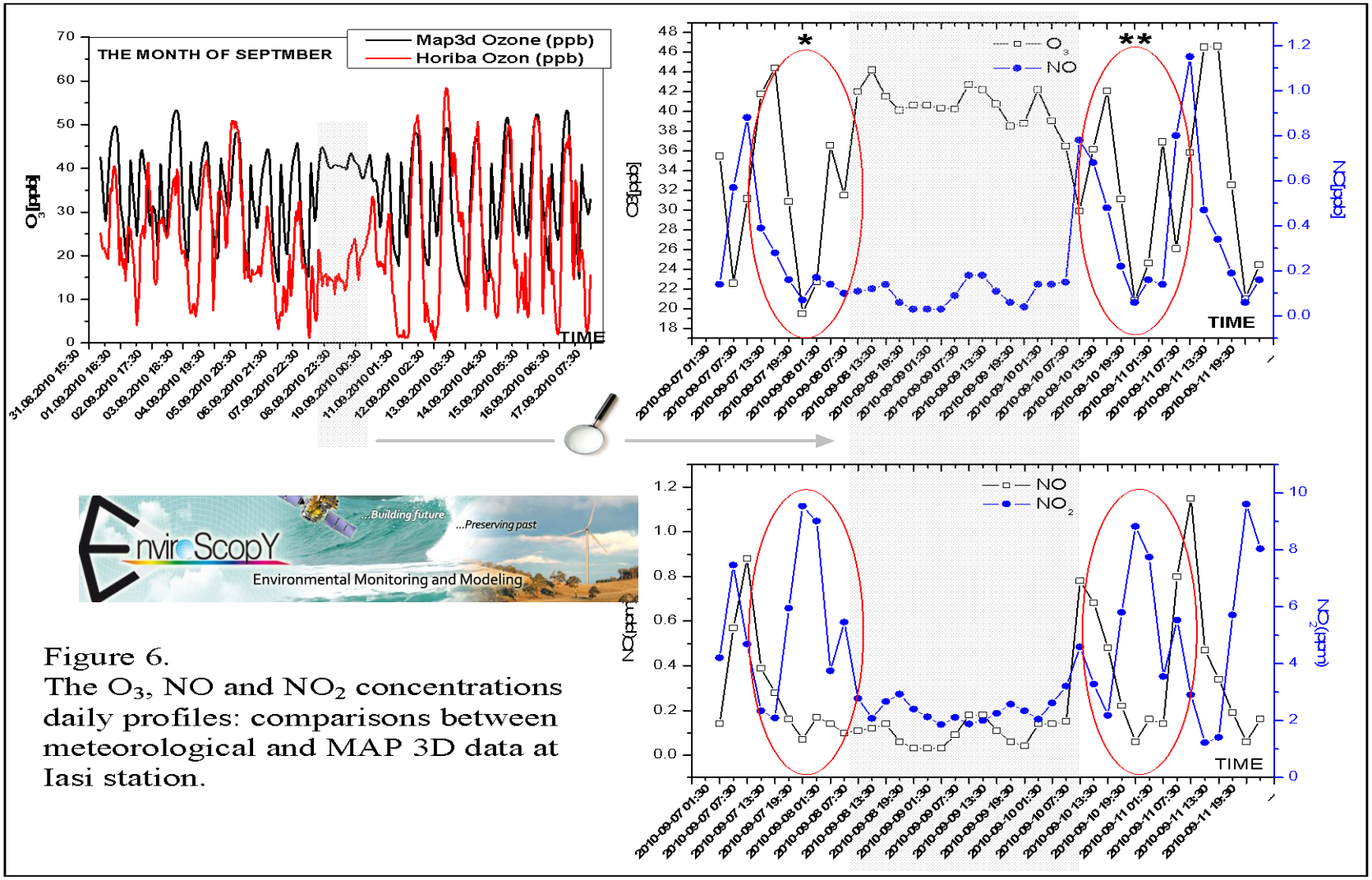
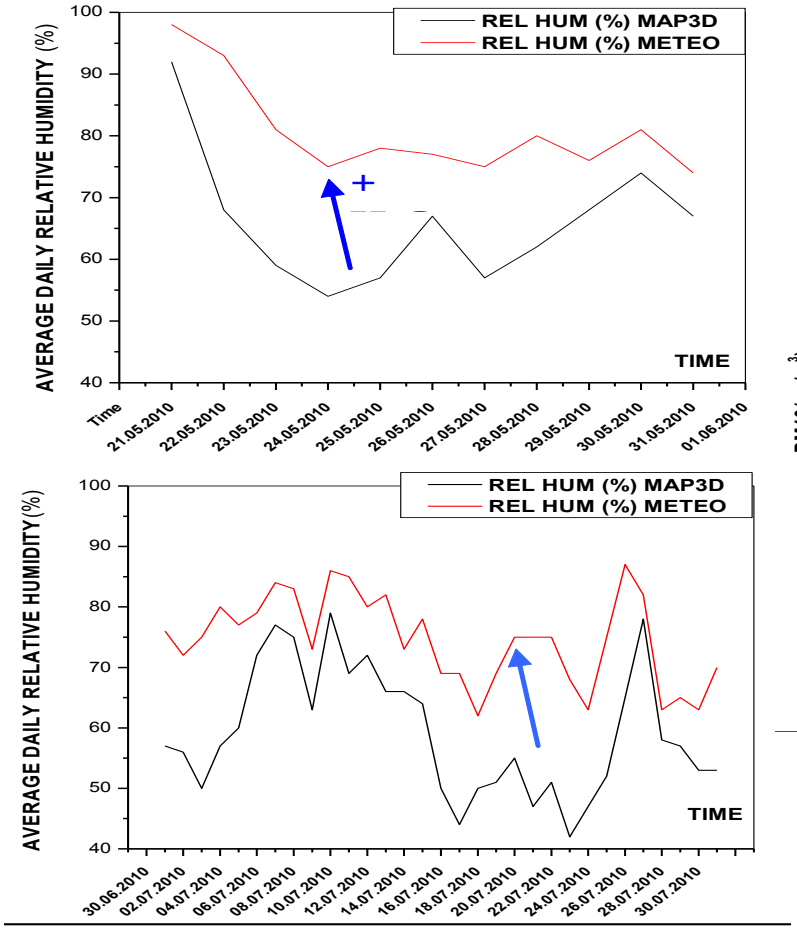
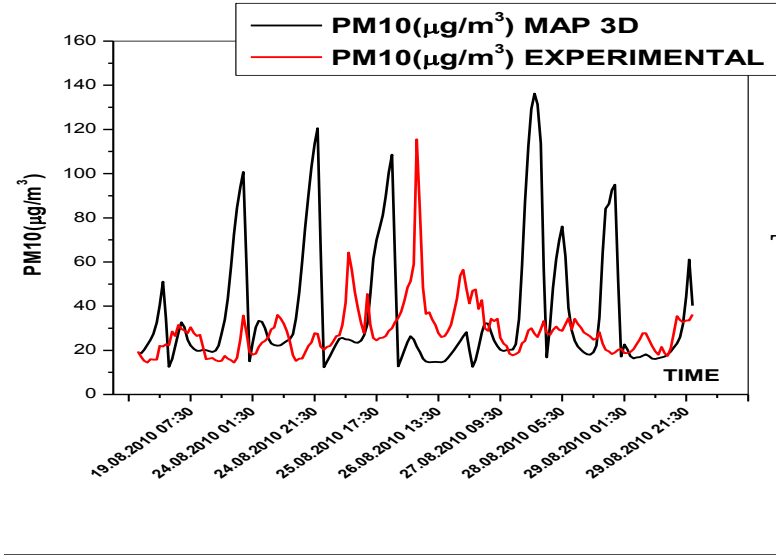


Figure 6.
The O_3, NO and NO_2 concentrations daily profiles: comparisons between meteorological and MAP 3D data at Iasi station.

MAP3D Validation ?..... Model Outputs vs Measurements !?





EnviroScopY

Conclusion & Perspectives

MAP3D

the acronym for "Mesoscale Air Pollution 3D modeling" is today successfully developed after 1.5 year of work and is available for environmental administrations, urban air quality agencies, industries, and decision makers.

Strengths

Strong expertise in atmospheric science and modeling software

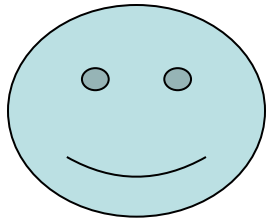
- Daily forecast of meteorological fields and pollutant concentrations (gases and aerosols) at regional and urban scales and over complex and mountainous terrains
- Daily indicators calculation for localization of air mass ozone regimes control
- User friendly and customizable web-based interface
- Impact scenario studies (new projects, infrastructure measures or short-term abatement policies)

http://map3d.inoe.ro/app/sites/pollution/9/2010-10-05

Map3D - -------> RO

→ Possibility of connecting the MAP3D results and forecasts to the Romanian measurement network data (air pollution and meteorological data) by developing an interface module (ftp access to the measurement data needed)

→ Possibility to develop a module for geo-referencing the simulations results in order to relate the calculated concentrations for example to the population density calculating a map with ppb/habitants

→ A data base will be built containing all the data of pollution episodes. This data base allows classifying the episodes and provides the data needed for running emission reduction scenarios.

→ Daily 3D Output allows comparing the model results to O3 and aerosol lidars as well as to PBL measurement (cf. Atmos. Environ. Couach et al. 2004)