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# THE PREV'AIR SYSTEM, AN OPERATIONAL SYSTEM FOR LARGE SCALE AIR QUALITY FORECASTS OVER EUROPE; APPLICATIONS AT THE LOCAL SCALE

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## ABSTRACT

Since Summer 2003, the PREV'AIR system has been delivering through the Internet<sup>1</sup> daily air quality forecasts over Europe. This is the visible part of a wider collaborative project - the PREV'AIR project - launched by the French Ministry for Ecology and Sustainable Development (MEDD), aiming at: (1) Providing technical support on atmospheric pollution management in Europe, in the framework of negotiations on trans-boundary air pollution<sup>2</sup>. (2) Providing large scale national air quality information based on numerical simulations and observations. The PREV'AIR system is a complementary monitoring tool with respect to the local information delivered by the French qualified associations in charge of regional air quality monitoring (AASQA<sup>3</sup>).

PREV'AIR relies on a chain of numerical tools: air quality simulation models, modules ensuring the provision of meteorological and air quality input data to these models, modules enabling the extraction and use of the numerical data computed by the system. The outputs of the PREV'AIR system (secondary pollutants forecasts and maps) are archived to build up a large scale air quality simulation data base over Europe.

The following public organisms are involved in the PREV'AIR project:

- **INERIS** (National Institute for Industrial Environment and Risks) is a public institution, under the supervision of the MEDD. Its mission deals with assessment and prevention of accidental and chronic risks due to industrial plants, chemical substances and underground

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<sup>1</sup> <http://prevnir.ineris.fr>

<sup>2</sup> This is done through technical programs related to the CAFE (Clean Air For Europe) project managed by the European Commission, and to the Convention on Long-Range Trans-boundary Air Pollution of the United Nations - Economic Commission for Europe.

<sup>3</sup> In France, since December 1996, air quality monitoring has been ruled by the Law on Air and Rational Use of Energy. About 40 qualified associations are in charge of air quality monitoring all over the French territory.

operations, towards health effects and environment. Within the **PREV'AIR** project, **INERIS** is in charge of the **PREV'AIR** architecture development, delivering daily air quality related information; providing and archiving air quality data produced within the PREV'AIR system. Moreover INERIS realises air quality studies for the **MEDD** including reporting and prospective analysis.

- **IPSL** (Pierre-Simon Laplace Institute) is a research institute in the field of environment, under the supervision of the National Centre for Scientific Research (CNRS). IPSL ensures the development of the chemistry-transport **model(s)** - the **CHIMERE model(s)** - used within the PREV'AIR system.
- **ADEME** (Agency for Environment and Energy Management) is a public institution under the supervision of the Ministries in charge of research, ecology and energy. It helps implementing public policies in the field of energy and environment at local, national and international levels. ADEME ensures the gathering, archiving and transmission of real-time air quality data locally collected by the AASQA. By this way, ADEME builds up the **BASTER** database used by the PREV'AIR system.

The MEDD financially supports the PREV'AIR project through the funding of INERIS activity.

- **Météo-France** joins the system in 2004. The organisation develops an other air quality model which will be tested during the summer.

Keywords: atmospheric pollutants, database, deterministic model, forecast, ozone.

## INTRODUCTION

Numerical simulations of pollution events with deterministic model has become easier during the last decade since computer ability increase. Then **3-dimensional** chemistry-transport-model runs for long-term simulation or real-time forecast are allowing over large scale area on a single workstation. High file storage capacity in data processing and fast internet download give the opportunity to use a large database of meteorological parameters and **pollutant** concentration measurements. The PREV'AIR system is supported by these technology progresses for delivering daily forecasts in operational conditions.

The PREV'AIR system is briefly presented hereafter, as well as the first conclusions that have been drawn after the first summer season of operation. Some examples of possible applications and use of the **PREV'AIR** system at local scale are presented.

## ARCHITECTURE OF THE PREV'AIR SYSTEM, INPUT DATA AND PRODUCTS

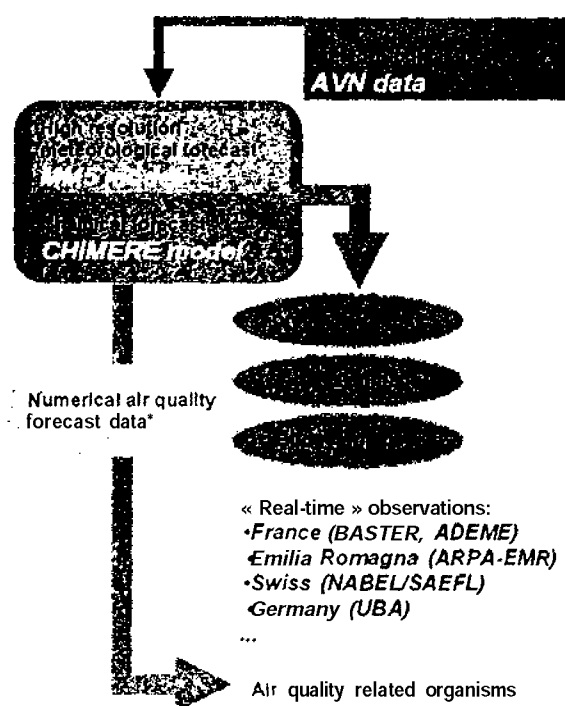
The PREV'AIR daily air quality forecasts are computed using the **CHIMERE** chemistry-transport **model(s)**. The **CHIMERE** model is used in its "continental" set up: pollutant concentrations are computed over Western Europe, with a 50 km\*50 km resolution. Last summer season, ozone and nitrogen dioxide forecasts were delivered. Each day, the forecast begins the day before (**D-1**), 00h UT and ends 96 hours later (**D+3**, 00h UT). The first day of forecast is actually rather a

simulation, whereas the following three days are "true" forecasts.

The meteorological forecasts necessary to perform the air quality forecasts are done in two steps: Low resolution meteorological forecast data are downloaded from the ftp server of the American National Weather Services, where they are produced using the Global Aviation Model (AVN) model. High resolution meteorological forecast data are then locally computed using the MM5 model.

Emission data come from the EMEP program<sup>4</sup>, with hourly, weekly and monthly temporal profiles from IER<sup>5</sup>. Contrary to meteorological data that change from day to day, emission data are set once and for all within the PREV'AIR system.

Observed air quality data are used by the PREV'AIR system (see hereafter); they are transferred by various European organisms. For example, the French real-time air quality data are downloaded from the BASTER ftp server time and used to correct a posteriori the CHIMERE air quality (D-1) simulations.



Since the 2003 summer season, the following output data have been made available on a daily basis and freely through the Internet:

- Maps of daily maxima and averaged forecast concentrations of ozone and nitrogen dioxide were available for D-1, D+0, D+1 and D+2. Figure 1 displays the ozone peak forecast issued on the 08<sup>th</sup> of August for D+0.
- Each day, the ozone peak observation data have been used to correct the D-1

simulated ozone peak. The resulting maps are referred to as "analyses". Figure 2 displays the ozone peak analyzed on the 09<sup>th</sup> of August for D-1. Figure 3 displays the absolute difference (in  $\mu\text{g}/\text{m}^3$ ) between the ozone peaks simulated by the CHIMERE model and the analyzed peaks.



Figure 1

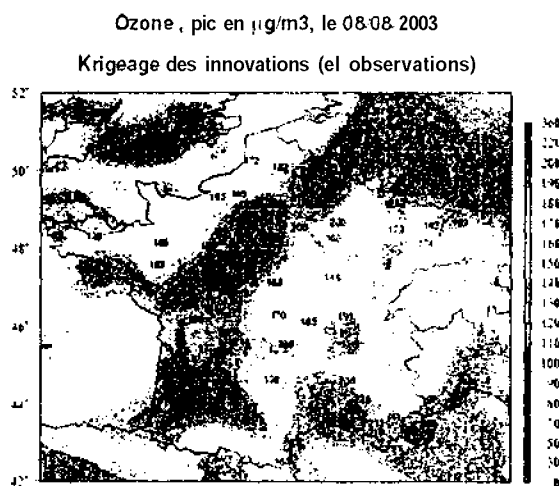


Figure 2

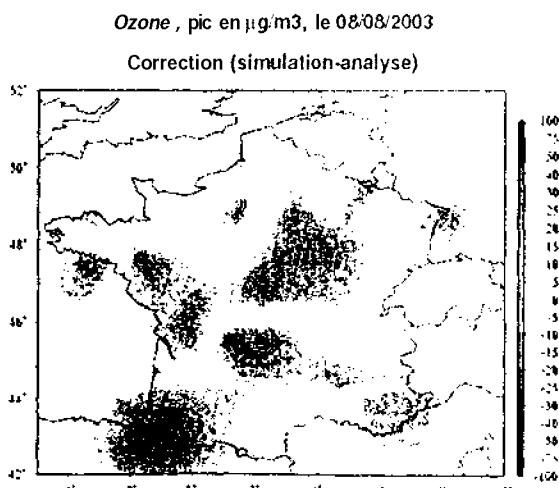


Figure 3

<sup>4</sup> Co-operative Program for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe

<sup>5</sup> Institut für Energiewirtschaft und Rationelle Energieanwendung, University of Stuttgart

## Reliability and Scores of the PREV'AIR System

During 2003 summer season, 174 days of forecasts have been issued: 85 % of forecasts realized without any problem; 4 % of the problems were related to hardware problems; 11% to software or data problems. The availability of the AVN data is of primary importance (the missing data is responsible for 5 % of the forecast failure). Some performance indexes (see table below) have been computed for the summer season, using the ozone peak concentrations measured in France and calculated for D-1 and D+0 by the PREV'AIR system. Regarding the ozone peak, the performances of the system are quite satisfying.

Statistical Indexes	Lag	Rural stations	Urban and suburban stations
Observed mean ozone peak ( $\mu\text{g}/\text{m}^3$ ) (number of observations used)	D - 1	127.3 (5244)	121.4 (31563)
	D + 0	127.3 (5244)	121.4 (31563)
Simulated mean ozone peak ( $\mu\text{g}/\text{m}^3$ )	D - 1	117.7	116.9
	D + 0	115.9	115.4
Normalized Bias (%)	D - 1	-6.9	-2.5
	D + 0	-8.2	-3.6
Normalized Mean Square Error (%)	D - 1	18.5	20.2
	D + 0	19.5	20.6
Correlation	D - 1	0.82	0.81
	D + 0	0.81	0.80
E20% (%) <sup>6</sup>	D - 1	72.1	73.7
	D + 0	68.7	72.0

## USE OF THE PREV'AIR AIR QUALITY FORECASTS AT THE LOCAL SCALE

In relation with the second objective of the PREV'AIR project, numerical air quality forecasts data have been made available to air quality related organisms. The only requirement for the demanding organism is to fill in a form specifying the exact domain on which the data are to be delivered. The numerical data are then put on a daily basis on the PREV'AIR web site. Two kinds of data are available over the specified domain: ozone and nitrogen dioxide surface data and 3D data for 22 chemical species. Up to now, about 15 organisms have applied for this service, for various applications: Downscaling and mapping of pollutant concentrations: Support to local expert forecasting; Provision of boundary conditions to local scale air quality simulation / forecast models.

### Example of the Provence-Alpes-Côte d'Azur (PACA) region

This Mediterranean region is complex from an air quality modeling point of view: it is a coastal region with complex terrain and meteorology (sea and valley breezes) with strong industrial emissions (Etang de Berre). It is beyond the scope of the PREV'AIR system to represent the detailed patterns of air pollution over such a region. Since June 2003, the feasibility of coupling the PREV'AIR system to a local air quality simulation system over PACA has been tested by

<sup>6</sup> Percentage of ozone peaks differing by less than 20% from the observed ozone peak

AIRMARAIX, one of the AASQA in charge of air quality monitoring over this region. Daily high resolution (3 km) air quality forecasts have been issued for the Marseille area. Boundary conditions came from the CHIMERE continental model; high resolution air quality forecasts were performed using the MM5 and CHIMERE models. The high resolution emission inventory derived from the ESCOMPTE exercise. The feasibility exercise showed the capability of the local air quality simulation system to catch the patterns of air pollution around Marseille. The implementation of the system is planned to begin at the end of October 2003, and the same set up as the one tested during summer 2003 should be ready by May 2004.

## PERSPECTIVES

In June 2004, a smaller domain only covering France has been added up to the continental one in the same outline apart from the horizontal resolution increased to approximately 10x10 km. This high resolution model should give more accurate forecasts, which in case of high ozone events should be provide to policy makers and media : (i) for people information and (ii) to take measure for reducing ozone level.

An other French model, **MOCAGE**, freshly including to the **PREV'AIR** system carries out some forecasts at global scale.

Aerosol forecasts have been delivered since the last winter season (starting end of October). More observation data will be used in the analysis and verification processes (Italy (ARPA-EMR), Switzerland (NABEL/SAEFL), Poland (Institute of Environmental Protection, Katowice), Germany (UBA)...). Sensitivity studies will be done regarding the analysis process. A general effort towards a more public- and user- oriented web site will be done.