Samaa software

and several applications

2002

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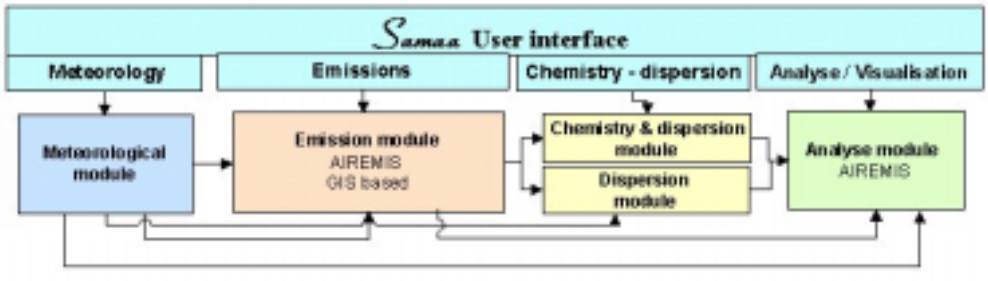
Samaa

Software for Air modelling and Analysis

In order to understand causes for some particular air pollution events and to potentially identify and assess actions to reduce them, ACRI-st has developed with two French Air Quality Survey Networks (Air Pays de la Loire and Atmo Auvergne), an integrated software, to simulate atmospheric air quality conditions. This software is called SAMAA (Software for Air Quality Modelling and Analysis)

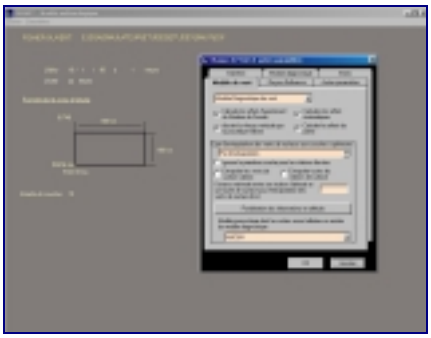
SAMAA is a GUI based "platform" used for managing the different steps of air quality studies (initialisation and parameterisation of pollutants emission, meteorological computations, dispersion and chemistry computations). It makes use of a GIS based emission model (AIREMIS), to which a meteorological model and a photochemical model can be interfaced. A puff dispersion model has recently been added in SAMAA. The whole system offers also powerful graphical capabilities for results display.



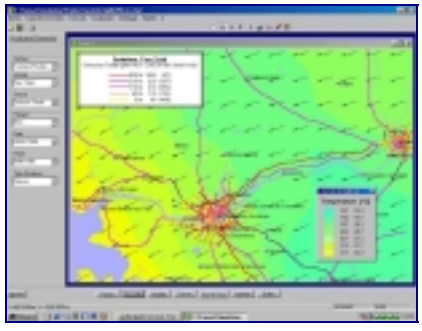
The **meteorological model** computes meteorological field that are used by the emission model and by the dispersion/photochemical model. CALMET, a public domain software developed by Earth Tech (Scire J.S. & all) is the meteorological model that is used for the first version of SAMAA; however, because the system has been developed in a modular way, any other meteorological model may be interfaced.

Interface and output of CALMET on Nantes (France)

Interface of CALMET



Temperature and wind fields



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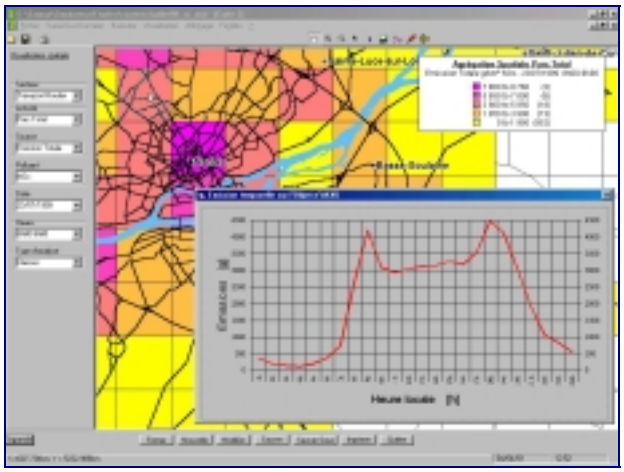
AIR POLLUTION MODELLING - SAMAA SOFTWARE

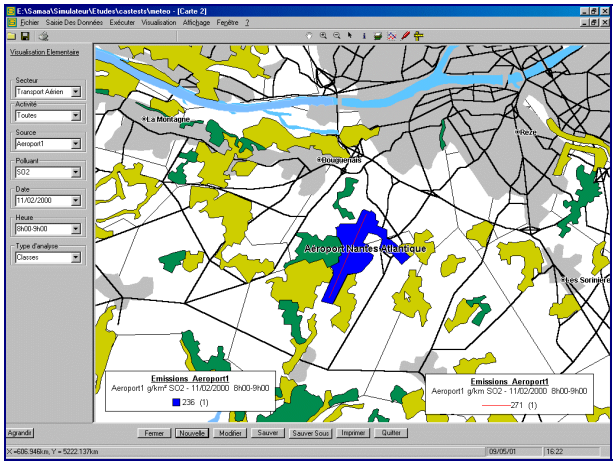
The **emission model AIREMIS** (developed by ACRI-st) computes emissions of different primary pollutants (NO_x, SO_2, CO, NMCOV, PS, CH_4) for various sources : transports (road and air), production and services, residential heating, and natural environment (vegetation and soil) on any kind of geometric object (segment, surface, point). The interface allows a non expert person to use it.

The development of this system in the frame of a GIS gives the opportunity to :

- manage emission data that are used downstream in the system (parameterisation and processing of geo-referenced data)
- visualise results of the five different modules (wind and temperature maps, emission maps, concentration maps)

The calculation of emissions linked with ***Road Transport*** is processed following a system that adapts the European standard methodology to local scale and hourly time step and makes use of output from a traffic model and statistical road traffic counting data. The car type distribution, ratio of heavy vehicles by type of road, the fuel characteristics, and temporary variations can be tuned via the interface. For each type of road the traffic flow variations during the simulation period is computed by mixing hourly (by type of day), weekly and monthly variations. These are obtained by a statistical processing of the road traffic counting data. ⇒





⇐ The emissions linked to ***Air Traffic*** include airplane emissions on land operations, during take off and landing, up to a 1000-meter (3280 feet) altitude. The methodology applied is based on an adaptation to an hourly scale and airport data of the European MEET Methodology, specialised in air traffic. It considers that emissions depend on the park breakdown, the number of planes that take off and land every hour, and the duration of each phase. Hourly and weekly variation of air traffic are specified by the user.

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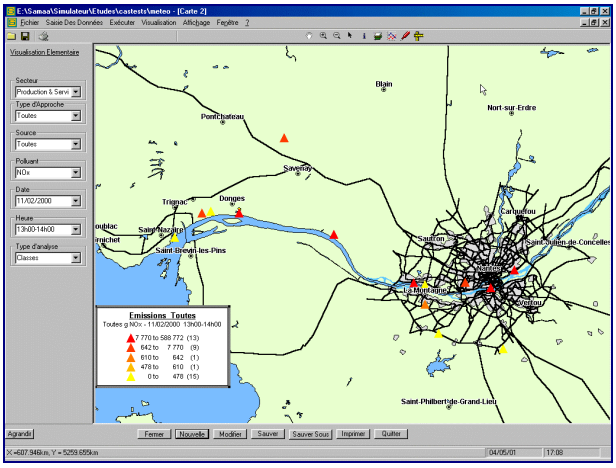
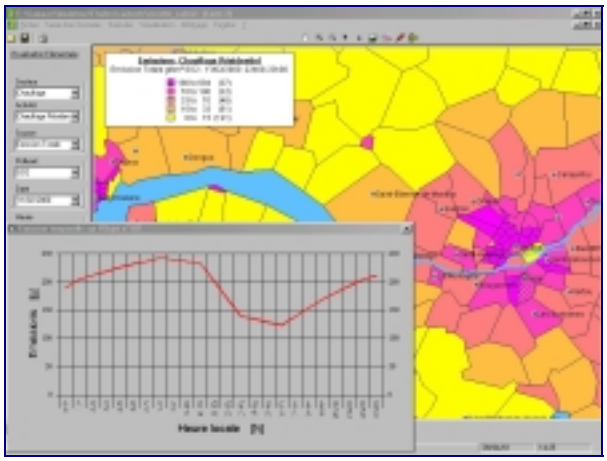
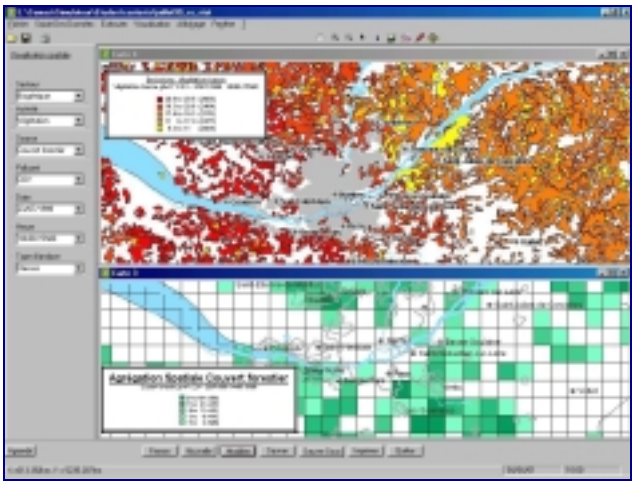
The emissions linked to ***industrial activities*** are calculated for different economy industries ('energy extraction / transformation', 'retail establishments', 'services' and service industry heating.) Methodology applied consists in calculating an annual flux for each pollutant and then breaking it down to the hourly rate for the simulation period depending on the industry's activity during the year. The different calculation methodologies of flux per annum defined in CORINAIR are proposed depending on the information and data available. ⇒





⇐ The emissions linked to ***Residential Heating*** are processed per unit area as diffuse sources. Methodology entails several phases applied to surface corresponding to statistical units used for population census and to associated 'habitat' data (number and size of the flats etc.). Hourly emission variations are directly linked to temperature variations computed in the meteorological module.

The calculation of emissions linked to the ***Natural Environment*** concerns several sources (forest areas, low vegetation, and soils). The emissions of different types of forest areas and low vegetation only concern the VOC emissions. The emissions linked to soil concern the emissions of nitric oxide – NO – in wetlands, as well as in forests, grasslands and croplands. ⇒



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The **photochemical model** allows to simulate dispersion and evolution of pollutants using the results of meteorological and emission models; however, likewise the meteorological model, any other photochemical model could be interfaced (providing compatibility between chemical description in emission and photochemical model).

The **puff dispersion model** allows to simulate the dispersion of puffs from several sources (punctual, linear, surface) using the results of the meteorological and emission models. CALPUFF, a public domain software developed by Earth Tech Inc has already been implemented in an earlier version.

The **visualisation module** allows to generate maps through the underlying GIS. The hourly outputs of the emission module can be visualised on the emitting object or on the cells of the calculating grid. The user can also choose to make a integration or a mean of the values over several hours (up to 24). The outputs of the meteorological, dispersion and chemical models are plotted as rasters and the created images, geolocalised automatically, can be overlaid to maps (especially those created by the AIREMIS emission model).

Samaa, is a PC software that is very innovative because of its underlying GIS, its modular approach, and its user-friendly interface; it is the result of more than 6 man-years of research and development. The emission computations reflect the state of the art European experience, and respect user requirements for an acceptable computation time.

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Scientific validation of Samaa

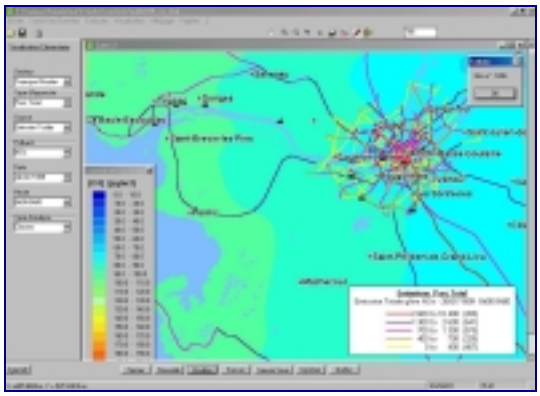
Case of Nantes (France)

Samaa has been validated on two 3-day simulations: the first one was dedicated to evaluate the “chemical processing” and the second to the “dispersion processing”.
Each of these exercises was split into tuning and validation steps. These four test cases were performed using various functionalities of Samaa:

- Meteorological conditions simulation based of data from the French national meteorological organism
- Hourly emissions calculation using the available data (road traffic, industries, residential heating and vegetation)
- GIS visualisation of the results

The concentration values calculated by SAMAA were confronted to the measured values of the local automatic observation station of the air quality survey network. The expert of the LCSQA has estimated that the performances of the system (photochemical and dispersion processing) give expected accuracy.

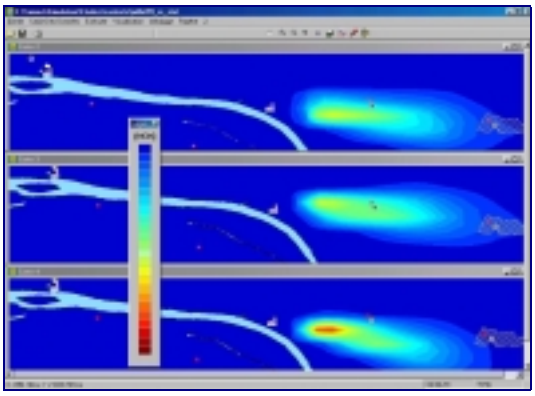
« Photochemical processing”



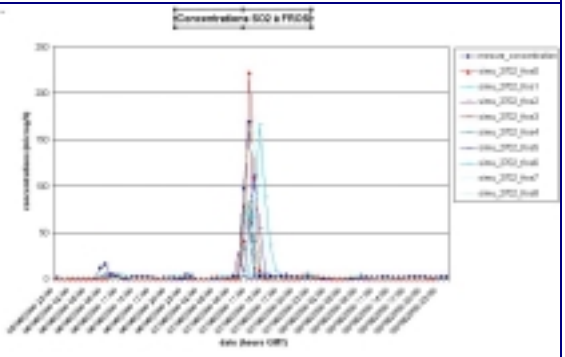
O3 fields and road traffic emissions of NOx

calculation-measurement comparison

« Dispersion processing »



NOx concentration field resulting from an industrial plant



calculation-measurement comparison

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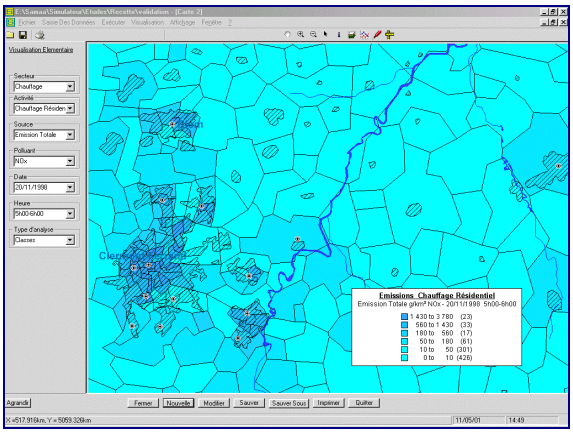
Application of Samaa

on other domains

The air quality survey network of Clermont Ferrand (ATMO AUVERGNE) was implied in the conception of SAMAA. It choose to use SAMAA as an research tool on air pollution, focussing attention to the effects of emission and meteorological conditions on photochemical phenomena of the domain.

Emissions from the road traffic

Emissions from residential heating



The emission module AIREMIS was also adapted on the city of Bogota D.C. in Colombia. The objectives of the study is to simulate concentration fields on the basis of an emissions inventory done with AIREMIS.
AIREMIS will be used by the staff of the organism in charge of the environmental quality of Bogota D.C.

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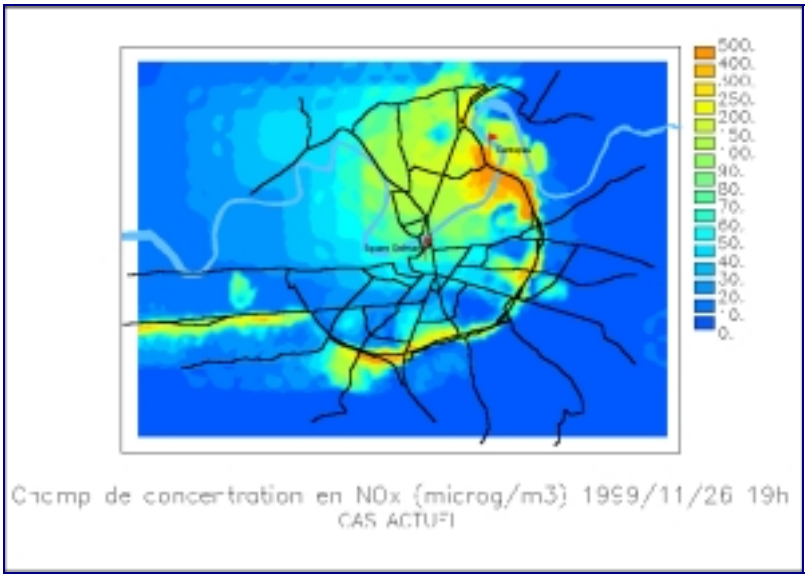
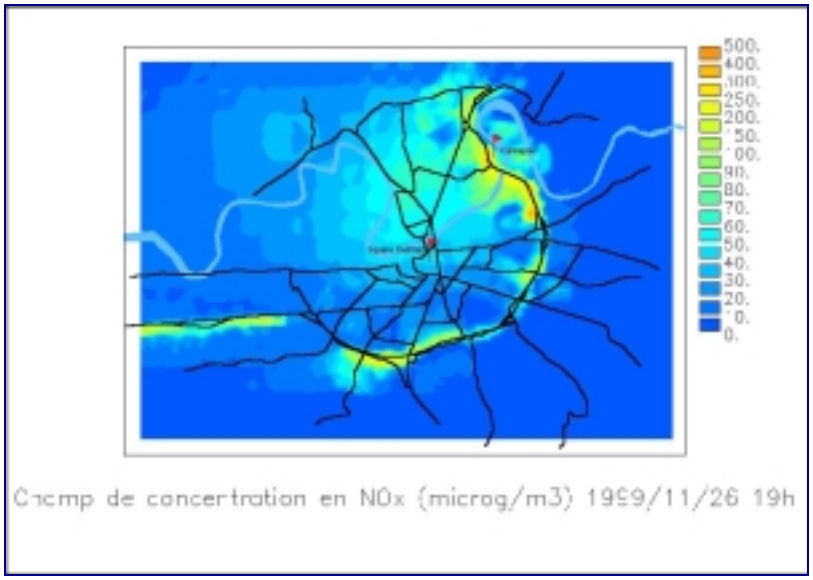
Dispersion modelling of traffic emissions (Albi, France)

Subject : dispersion modelling of traffic emissions for Air Quality impact of a new road infrastructure in Albi (France).
Three cases were studied :

- the present configuration
- the reference state : future case without the new infrastructure
- future case with the new infrastructure



Present configuration



Future case with the new infrastructure

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Air quality study for A3 freeway (Paris, France)

Subject : dispersion modelling of pollutants impacted by the construction of noise protection walls along a freeway in a residential zone.
Three case were studied :

- case 1 : the present configuration
- case 2 : the reference state : future case without protection walls (2012)
- case 3 : future case with protection walls (2012)

An exposition factor of the population living near the freeway to the pollutants was computed.

present configuration

Future case with protections walls

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REFERENCES

Studies at urban and regional scale

« Training for the use of the emissions calculation software AIREMIS in order to perform the emissions inventory on de Bogota D. C. »

- **Software : AIREMIS**
- **Client : UNIANDES**
- **Date : September 2001**

« Assistance to the design of a Regional Air Quality Plan in French Brittany »

- **Software : AIREMIS**
- **Client : AIR PAYS DE LA LOIRE (Air Quality Survey Network)**
- **Date : Juin 2001**

« Air quality study for the A3 Freeway (France)»

- **Software : ANSWER**
- **Client : DDE 93**
- **Date : Août 2000.**

« Dispersion modelling of traffic emissions »

- **Software : CALPUFF**
- **Client : CETE Est**
- **Date : Août 2000.**

« Clermont-Ferrand : setting up of the air modelling system Samaa »

- **Software : Calmet, Calgrid**
- **Client : ATMO AUVERGNE (Air Quality Survey Network)**
- **Date : juillet 1999-2000.**

« Nantes : setting upof the air modelling system Samaa »

- **Software: Calmet, Calgrid.**
- **Client : AIR PAYS DE LA LOIRE (Air Quality Survey Network)**
- **Date : Août 1999-2000.**

« Dispersion Modelling for the design of a new sincineration plant»

- **Software : RADM.**
- **Client : SYCTOM.**
- **Date : mars 2000.**

« Issy-les-Moulineaux : Dispersion Modelling of the plume of an incineration plant»

- **Software : Answer**
- **Client : Syndicat Intercommunal pour la Collecte et le Traitement des Ordures Ménagères.**
- **Date : octobre 1999.**

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Studies at regional and global scale

« ASTHMA : Development and exploitation of a dispersion model on pollutants and allergens in the atmosphere, and development of new methodologies for emissions »

- **Software : Calpuff**
- **Clients : C.E.E, Zambon group**
- **Date : octobre 1998-2001.**

« MSDOL : Monitoring of the stratospheric depletion of the ozone layer »

- **Software: Rose**
- **Clients : C.E.E**
- **Date : décembre 1997.**

Studies at local state

« « Numerical simulations of the dispersion of fire fumes in the Tokyo Gaikaku Expressway »

- **Software : Answer.**
- **Client : SETEC-T.P.I.**
- **Date : septembre 1997.**

« Air pollution study in Vitry-sur-Seine and Ivry-sur-Seine (France) »

- **Software : Radm.**
- **Client : Hydratec (groupe SETEC).**
- **Date : 1996.**

« Dispersion of pollutants on the A14/A86 freeways »

- **Software : Answer.**
- **Client : SETEC-T.P.I.**
- **Date : 1993.**

« Dispersion of the pollution resulting from an freeway tunnel »

- **Software: Radm.**
- **Client : Hydratec (groupe SETEC).**
- **Date : 1992.**

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