3.1 Specification of the Products of the Baseline and Extension Local & Regional Air Quality Forecasting Service

3.1.1 Product of the AIRES Air Quality Forecast System

The products are generated by the AIRES Air Quality Forecast System. This system aims at monitoring and forecasting the concentration of several chemical species such as ozone, sulphur dioxide, nitrogen dioxide, carbon monoxide etc… near the surface and at regional scale. It is currently operated on the area of South-East of France, Corsica and East Italia including two high-resolution nested domains around the cities of Marseille and Nice. The computations are performed every night so as to provide meteorological and chemical analyses for the day before along with forecasts from Day+0 to Day+2 available on through a dedicated WEB site shown below.

The local Air Quality service will be based on the following ingredients:

- input data: global meterological analysis and forecast, continental chemical data
- auxiliary data: EO data
- algorithm: meteorological, emissions and photochemical computation ; post-processing

Product description	
Summary	predictions and analyses of near surface air pollution concentrations
Product properties	
Parameter(s)	O3,NO2,SO2
Accuracy	TBD
Geometric resolution	PACA/Corsica/East of Italia: 9 x 9 km^2 MARSEILLE: 3 x 3 km^2 NICE: 3 x 3 km^2 Unequal vertical resolution with 50m in the near surface layer
Grid / projection	Lambert conformal projection
Spatial coverage	From 4.4 to 11° in longitude, from 40.5 to 45° in latitude
Temporal coverage	Daily 72 hour forecast Archive since 2005

Data format	Fortran binary, NetCDF
availability	Operational
Production process	
Method/algorithm	limited-area, nonhydrostatic, terrain-following sigma-coordinate mesoscale modelling of the atmospheric circulation.
Model / assimilation	Meteorology: MM5 from NCAR Chemistry: CHIMERE-CTM from IPSL
references	Vautard, R., M. Beekmann, J. Roux and D. Gombert, 2001, Validation of a hybrid forecasting system for the ozone concentrations over the Paris area. *Atmos. Environ*., **35**, 2449-2461. Anthes, R.A. and T.T. Warner, 1978: Development of hydrodynamic models suitable for air pollution and other mesometeorological studies. *Mon. Wea. Rev*., **106**, 1045-1078. See also the websites: http://www.mmm.ucar.edu/mm5/mm5-home.html http://euler.lmd.polytechnique.fr/chimere
Quality standards	
Production	Verification with measurements performed by the air pollution monitoring network operated by local agencies
Product	Statistical analyses of the difference between the model forecasts and the measurements (OmF)
validation	Involvement in the ESCOMPTE modelling exercise: comparison between various models and an intensive measurement campaign (http://medias.obs-mip.fr/escompte/index.en.php)
Input data	
EO data	USGS terrain and landuse data set, sea surface temperature
Other data	NCEP meteorological analyses
Optional or other specific properties (if applicable)	
Historical archive	Data base of forecasts since 01.06.2004
Offline/NRT	NRT

	Archive since 2005
Visualization standards	PNG images.
Underlying primary user requirement(s)	
Key requirement	Tbd
Originator(s)	tbd

Table 3.1-1: Characteristics of the AIRES Up-scaled product

4 PRODUCT GENERATION

4.1 The AIRES Up-scaled Sub-Service

4.1.1 System overview

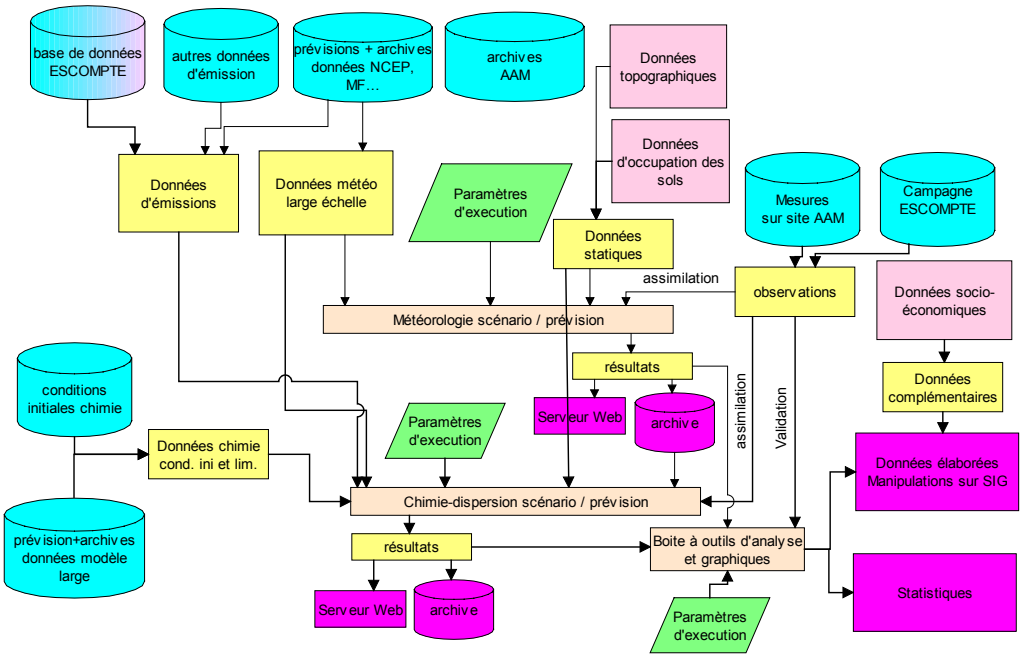

Figure 4.1-1: Overview of AIRES regional Air Quality Forecast & surveillance system

The diagram summarises the AIRES process. The AIRES Air Quality Forecast System consists of two major components:

- The PennState/NCAR mesoscale model MM5 is used to compute the meteorological variables (wind and temperature among others) that are needed to drive the chemistry-transport model (CTM)

- the CHIMERE, developed by IPSL, is used to predict the concentrations and deposition of several tropospheric species.

The CHIMERE multi-scale model has been primarily designed to produce daily forecasts of ozone, aerosols and other pollutants and make long-term simulations for emission control scenarios. CHIMERE runs over a range of spatial scale from the regional scale (several thousand kilometers) to the urban scale (100-200 Km) with resolutions from 1-2 Km to 100 Km. It includes the following features:

- The chemical mechanism (MELCHIOR) is adapted from the original EMEP mechanism.

- Photolytic rates are attenuated using liquid water or relative humidity
- Boundary layer turbulence is represented as a diffusion (Troen and Mahrt, 1986, BLM)
- Vertical wind is diagnosed through a bottom-up mass balance scheme.
- Dry deposition is as in Wesely (1989). Wet deposition is included
- Six aerosol sizes represented as "bins" in the model.
- Aerosol thermodynamic equilibrium is achieved using the ISORROPIA model.
- Several aqueous-phase reactions considered
- Secondary organic aerosols formation considered
- Advection is performed by the PPM (Piecewise Parabolic Method) 3d order scheme for slow species.
- The numerical time solver is the TWOSTEP method.

The anthropic emissions are computed with an emission inventory specific to PACA and EMEP emissions outside the PACA region. The biogenic emissions are calculated online with respect to the given atmospheric condition (temperature, radiation, wind) and the given land use type (CRIGE data).

The meteorological forecast is done by the NCAR/PennState mesoscale model MM5. For initial and boundary conditions the model uses the NCEP global forecast and interpolates the variables on the selected domains.

This system is currently operated on the area known as “Provence-Alpes-Côte d’Azur” (and referred to as “PACA”, that covers South-East France) including two high-resolution (3 km) nested domains around the cities of Marseille and Nice. It has been extended to Corsica and east Italia. Physiographic information (orography, land use type) is taken from the USGS database for the coarse domain or from nonpublic regional database for highermost resolution. The model uses terrain following σ coordinate in the vertical with 25 unequally spaced layers, where a more dense resolution is used in the lowest part of the model. The model top for the operational uses is 100 hPa.

The system includes automatic download of the NCEP global meteorological analyses and forecasts via ftp as well as analyses and forecast of the chemical species concentration over Europe provided by the PREV’AIR system (http://prevair.ineris.fr/) for use as boundary conditions. The forecasts (meteorology and chemistry) are made available at around 9:00 UTC on a website.

Number	Origin	Short name	Description	Backup
1	USGS terrain data	EO	Gridded topography data with 1-degree, 30-, 10-, 5- , 2-minutes and 30-seconds resolution	n.a.
2	CRIGE (Comité Régional de [illegible] l’Information	EO	Gridded topography data over PACA with 10 m resolution	n.a.

	de l'Information GEographique) terrain data		with 10 m resolution	
3	USGS landuse data	EO	Gridded landuse data with 1-degree, 30-, 10-, 5- , 2-minutes and 30-seconds resolution	n.a.
4	CORINE land cover	EO	Gridded landuse data with 100m resolution	n.a.
5	NCEP/GFS global forecast	database	Gridded meteorological variables with 1 degree resolution on standard pressure levels	n.a.
6	EMEP Emission data set	database	Gridded emission rates of major components	n.a.
7	AAM Emission inventory over PACA	database	High-resolution gridded emission rates of major components	n.a.

Table 4.1-1: Input data of the AIRES Up-scaled service

Category	Name	Function	Description
Interface sub-system			
Input data	FTP_METEO	Meteo data acquisition	This task is programmed on a daily basis. Availability of meteo data is checked and data are retrieved from the server (NCEP ftp site)
Input data	FTP_CHIMIE	Air quality data Boundary conditions acquisition	This task is programmed on a daily basis. Availability of meteo data is checked and data are retrieved from the server (PREV'AIR ftp site)
Input data	EXTC_ZONE	Zone Extraction	Extraction of sub-zones from global files. Extracted zones are archived in the system.
Input data	FMTN_2HDF	Format converter	Conversion of Meteo and chemistry files from native format towards NetCDF format
Input data	DB_EMIS	Emission data acquisition	This task is programmed on a daily basis. Availability of emission data is checked and data are retrieved locally from a database
Input data	DB_SOL	Land use data acquisition	This task is programmed on a daily basis. Availability of land use data is checked and data are retrieved locally from a database
Input data	DB_SCEN	Parameters extraction in	This task is parameterised to perform a data extraction in

		surveillance mode	surveillance mode (scenario)
Interface sub-system			
Results output	TECP_SCR	Tecplot Script	Graphical results display Script towards a WEB server
Results output	GEN_2HTML	WEB pages generation	Function of WEB pages generation refreshed after each computation
Results output	CONV_2SHP	Format converter	Conversion of results files into a format type ESRI SHP (DB compatible) for post-processing with ArcView
Computation sub-system			
Intermediate results	HDF_2FMTEM	Format converter	Conversion of Meteo and Chemistry files from NetCDF towards the models input formats
Intermediate results	CAL_MET_SCR	Meteo computation Script	This script includes all steps required by the meteo computation. In particular, it includes the sizing parameters, the code compilation using these parameters, and computation run itself.
Computation sub-system			
Output results	FMTSM_2HDF	Format converter	Conversion of Meteo and chemistry output files from native format towards NetCDF format
Output results	CAL_POST	Post-processing computation	Post-processing of eteo/CTM results : statistical computations, generation of HTML pages of WEB server

Table 4.1-2: Sub-processes of the AIRES Up-scaled service

Number	Short name	description	Key features
1	O_3	Ozone	Near surface level
2	NO_2	Nitrogene dioxide	Near surface level
3	SO_2	Sulfurdioxide	Near surface level
4	HCOH	Formaldehyde	Near surface level
5	CO	Carbonmonoxide	Near surface level
6	Humi	Humidity rate	Near surface level
7	T2	Temperature	Near surface level

Table 4.1-3: Output of the AIRES Up-scaled service

Technical requirements

External interface(s)

For NRT processing direct ftp-transfer of the NCEP global meteorological forecast is automatically performed every day. Results are distributed immediately through the ACRI-ST web-interface and the data are archived.

Verification and quality control

Verification and quality control is performed every forecast cycle by comparing the prediction with measurements from observation stations operated by the local air quality monitoring agencies. A statistical analysis of the OmF is performed in order to detect abnormal behavior of the system.

Hardware

The AIRES Air Quality Forecast System runs on a Linux PC with dual CPU processor Xenon (2.4 Ghz).

Software

The source code of all processes is written in FORTRAN 90. The graphical Interface currently uses Ferret for post-processing and visualizing data.

4.1.1 References

Vautard, R., M. Beekmann, J. Roux and D. Gombert, 2001, Validation of a hybrid forecasting system for the ozone concentrations over the Paris area. *Atmos. Environ.*, **35**, 2449-2461.

Anthes, R.A. and T.T. Warner, 1978: Development of hydrodynamic models suitable for air pollution and other mesometeorological studies. *Mon. Wea. Rev.*, **106**, 1045-1078.

See also the websites:
http://www.mmm.ucar.edu/mm5/mm5-home.html
http://euler.lmd.polytechnique.fr/chimere