



ACTIVITY REPORT 2005

CEREA

Research and Teaching Center in Atmospheric Environment

Joint Laboratory
Ecole Nationale des Ponts et Chaussées
Electricité de France R&D



CEREA

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Joint LABORATORY ENPC-EDF R&D

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CEREA was created in 2003 as a research center at Ecole Nationale des Ponts et Chaussées and has become in 2004 a joint laboratory ENPC-EDF R&D, with two locations (ENPC/Champs sur Marne and EDF R&D/Chatou). Its research activities concern the modeling of the atmospheric environment with a special focus on the assessment of environmental impact of transport and energy production (thermal or nuclear). These activities are coupled with the programs of EDF R&D and strongly related to other organizations of the French Ministry for Transport, the METLMT, through its Research Directorate (DRAST).

Other strong relationships have been developed for specific applications, with IRSN for radionuclides and with INERIS for impact studies or environmental forecast.

CEREA organizes its multidisciplinary activities through four research teams: fluid mechanics and dispersion at local scale, dispersion at regional and continental scales, multiphase modeling, and data assimilation. The data assimilation team is also part of an INRIA project, the CLIME project.

Research topics

CEREA develops modeling activities mainly with two numerical models: a CFD (Computational Fluid Dynamics) tool, Mercure_Saturne, for small scale dispersion (urban pollution, industrial risk), and a Chemistry Transport Model, Polair3D, for regional and continental dispersion. It also develops a modeling platform, Polyphemus. Some appropriate physical parameterizations and multiphase reactive box models are developed and plugged in these three-dimensional models.

The resulting models are compared to measured data and used for impact studies or environmental forecast. In this framework, the research actions devoted to data assimilation (coupling between model outputs and measurements) aim at improving the ability of models to make good forecasts and/or perform inverse modeling of pollutants.

Key facts 2005

In 2005, ten publications in international peer-reviewed journals with the first author belonging to CEREA have been published or accepted. Two PhD works have been successfully defended by Yelva Roustan (Modeling of atmospheric dispersion of mercury and heavy metals) and Vivien Mallet (Ensemble forecast for chemistry-transport models). The joint project with INRIA (Clime), devoted to data assimilation and environmental simulation, has been officially labelled by the project committee of INRIA. A new modeling system, Polyphemus, aimed at hosting the models developed at CEREA, has been developed.

The involvement in EDF R&D programs has been strengthened, for instance with the participation in the European integrated project NEEDS (for the cost-benefit analysis of externalities related to air pollution) and the arrival at CEREA of a team issued from EDF R&D (observation of the atmospheric boundary layer). Moreover, high-level impact studies have been performed for the thermal branch of EDF.

Through its participation in the international exercise MICS Asia (with Karine Sartelet) and in the submission of two European projects (FUN2, HEIMTSA, in the second step of review), CEREA has reinforced its international legibility. The strategic partnership with IRSN and INERIS has been

strengthened, especially through the Polyphemus system.

A joint project with IPSL devoted to an observational network of air quality and meteorology at regional scale has been retained (Sesame program of region Ile de France).

Research groups

Local scale and fluid mechanics

(Group leader: Bertrand Carissimo)

The research actions are related to the preoccupations of the French Ministry for Transport (urban pollution) and those of EDF (dispersion at an industrial site). They mainly rely on the development of an integrated numerical model, *Mercure_Saturne* (EDF).

This code is based on a general purpose CFD tools, *Code_Saturne*, which has a wide range of applications. In this framework, the team adapts or develops parameterisations suitable for the atmospheric environment applications (cloud scheme, atmospheric radiative scheme, chemistry, aerosols ...).

There is also an activity related to the observation of the atmospheric boundary layer with appropriate means (sodar, anemometers, UHF radar, sonic mast).

Cloud scheme for cooling tower plume and fog

The warm cloud microphysical scheme previously developed for the simulation of cooling tower plumes (PhD work of Emmanuel Bouzereau) has been successfully applied to a first case of fog development and dissipation observed at the Cabauw tower. These first simulations have been performed in one dimension and show that the introduced scheme, that can also predict the droplet distribution, is suitable for both applications. Other validations are planned.

Urban dispersion

The topics related to urban dispersion have been investigated by modeling dispersion in a network of idealised buildings (PhD work of Maya Milliez). The outputs of *Mercure* have been compared to measured data obtained in an experience carried out in the United States (the MUST campaign). The new development is concerned with the simulation of concentration fluctuations (using an Eulerian transport equation for the variance of concentration) which compares well with the observations of MUST.

Radiative scheme for complex geometries

We have started to develop a scheme suitable to study radiative effects in a city. This will be able to take into account both the solar and infrared radiations in a complex geometry (buildings and street canyons). This scheme is derived from numerical techniques used for combustion. We have compared the results to simple experiments giving the variation of albedo as a function of solar zenith angle and encouraging results have been obtained. Further validations are in progress.

Dispersion for industrial site

In his PhD work, Etienne Demael has compared the *Mercure* results with models which are classically used for these applications (Gaussian plume models). The differences have been quantified and explained, in particular for the behaviour very near the source. The work is now progressing with the simulation of an actual industrial site, including buildings and topography, for which the mesh and simulation domain have been constructed.

Wind potential estimates

In this area, the goal is first to try to improve the estimates that are currently obtained with very simple models. These models fail in complex terrain and along the coast with local circulations induced by the thermal contrast. The second objective is to quantify an additional effect of "mask" found in very large wind farms when a large set of wind mills modifies the local flow and can reduce the energy potential. This work that has just started will be performed by introducing this masking effect in *Mercure* by ways of a drag within the flow (PhD work of Laurent Laporte).

Estimation of pollution induced by roads and tunnels

A project has been initiated with CETU and LCPC to estimate the pollution induced by roads and tunnels (Stéphanie Lacour). On the basis of measured data issued from three cases (Landy tunnel, a road in Northern France, the Jatveg street in Denmark), a classification of pollution has been proposed in order to distinguish the "background" component and the "local" component. Some strategies have been proposed in order to simulate the long-term impact of such infrastructures.

Moreover, a comparison of turbulent parameterisations has been performed for the Eulerian modeling of dispersion at small scales (in the vicinity of a road).

Observation of the atmospheric boundary layer

A campaign of intercomparison of sodars has been initiated in order to evaluate the quality of results and the acoustic disturbance (the campaign is located in Beauce region).

A joint project with the observational team of the IPSL Institute has been retained by Ile de France region to create a regional observational network devoted to environment (SESAME program).

Modeling at regional and continental scales

(Group leader: Luc Musson-Genon)

The team is focused on air quality modeling from regional to continental scales. The applications are photochemistry (ozone), heavy metals (like mercury or lead) and radionuclides. The activities range from process studies to forecast and impact studies.

These activities now rely on a new modeling system, the Polyphemus platform, which hosts the Chemistry-Transport Model of CERE, Polair3D.

Many joint projects with other teams have been initiated with this modeling system, from forecast of radionuclides (with IRSN, France) or photochemistry (INERIS, France or Meteo-Chile) to impact studies (with EDF Polska; with the University of Stuttgart, IER, for Cost-Benefit analysis in the framework of the European project NEEDS).

Development and applications of the Polyphemus platform

A new modeling system has been developed, through the work of Vivien Mallet and Denis Quélo: the Polyphemus platform, a multi-function and multi-scale modular system for atmospheric modeling:
(www.enpc.fr/cerea/polyphemus).

The new approach with Polyphemus is to split the modeling systems into 4 distinct levels:

- Physical parameterizations and preprocessing with the object-oriented AtmoData library (potentially shared with any team involved in modeling, whatever the model is);
- High-level drivers of models as black boxes (for data assimilation, for

coupling, for Monte Carlo simulations, for ensemble runs);

- Numerical models as such (for instance, Polair3D);
- Post-processing facilities, for instance for statistics and model-to-data comparisons with the US EPA recommendations, through the Python library AtmoPy.

At this stage, levels 1, 3 and 4 have been completed and level 2 is a work in progress. This system has been used for numerous applications (listed below), implying a growing number of teams in joint projects.

The advantage of this structure is the possibility to have a multi-modeling approach through the available parameterizations.

In 2006, Polyphemus should host other models at local and regional scales.

Air quality ensemble forecast

Due to the wide range of uncertainties, a promising approach for air quality forecast is related to ensemble techniques. The PhD work of Vivien Mallet (defended in December 2005) has focused on the assessment of the a priori spread in the outputs of a Chemistry-Transport Model through Monte-Carlo methods and a multi-modeling approach through the Polyphemus platform (article accepted for JGR). The next step is to improve the forecast through an appropriate combination of the available models (typically 50 configurations with the Polyphemus platform). A work has underlined the limitations of usual methods (ensemble means for instance) and has proposed new ensemble methods related to the so-called super-ensemble methods and to machine learning.

Moreover, the coupling to the Prev'air platform of INERIS has been achieved (Hervé Njomgang and Vivien Mallet) and the computation of an extensive set of model-to-data statistics has been initiated (Christelle Bordas and Vivien Mallet).

Mercury and heavy metals

These works have been done in the framework of the PhD thesis of Yelva Roustan (defended in December 2001).

The development of the mercury model has been completed with two available models (a simple one based on the so-called Petersen formulation and a model based on a gas/phase-aqueous/phase chemical mechanism). Model-to-data comparisons

have been performed for year 2001 over Europe. Moreover, an innovative sensitivity analysis has been developed (see section devoted to Data Assimilation) and inverse modeling with respect to boundary conditions has been performed (two submitted articles). Another model version has been developed with the coupling to the gas-phase mechanism RACM in order to investigate the impact of forced fields for oxydant species.

For lead and cadmium, two additional approaches have been considered. The first one consists in representing the aerosol size distribution with several diameters rather than with a simple mass mean diameter. The second one is to add to the size resolved aerosol module of POLAIR3D (SIREAM) some "inert" heavy metals. A sensitivity study and model-to-data comparisons have been performed.

Impact studies at continental scale

A key application of such works is related to impact studies at European scale. A work has assessed the sensitivity of ozone concentrations with respect to emissions (Vivien Mallet and Bruno Sportisse, article accepted in JGR). The sensitivity study concerned the temporal, spatial and chemical features of NO_x and COVs emissions.

CEREA is also implied in the European project NEEDS, devoted to Cost-Benefit Analysis. The objective is to compute transfer matrices to be used for Cost-Benefit analysis. The project has begun and should allow joint works with EMEP/West and IER Stuttgart.

Moreover, the joint work with EDF Polska has been strengthened with the visits of Luc Musson Genon and Denis Quélo in Polska and the welcome of Artur Wyrwa at CEREA. The use of Polyphemus/Polair3D by EDF Polska and by the consortium of associated polish universities has begun.

Dispersion of radionuclides

An important application of Polyphemus is the forecast of the dispersion of radionuclides. This work is done in a joint project with the Emergency Center of IRSN. Polyphemus is the basis of the forecast system of IRSN at regional/continental scales.

An extensive work (Denis Quélo and Bruno Sportisse) has been devoted in 2005 for simulating the Chernobyl's accident. A sensitivity analysis has been performed with respect to the meteorological parameterizations in order to investigate the sensitivity of wet scavenging (a key process

for this kind of simulations). Other applications have concerned the simulations of the ETEX exercise and of the Algéciras accident (Monika Krysta and Marc Bocquet).

Escompte

Mohammad Taghavi has taken part in the model intercomparison study ESCOMPTE, with a focus on ozone modeling for Intensive Observation Periods 2a and 2b (21-26 June 2001).

For the Thermal Mission of EDFs Branch Energy a dedicated study has been realized in order to estimate the impact of Martigues Power plant on particulate matter over the Marseille-Berre area. This work is a follow-up of a study devoted to ozone. The aerosol model is SIREAM and preliminary model-to-data comparisons have been performed.

Multi-media modelling

Impact of air quality pollutant on human health is an important and difficult field of application of our modeling system focused on thermal power generation. In this domain, a work (PhD thesis of Solen Quéguiner) has begun by coupling the outputs of Polair3D for lead and cadmium (air concentration and ground deposition) with the ground transfer model OURSON developed at LNHE Department of EDF R&D. This OURSON model allows to follow pollution in the ecosystems, the cultures and hydrological network in order to estimate doses for human beings. The OURSON model has been modified and a first test is scheduled over the Seine basin (PIREN/SEINE program). An extent of this work to mercury is planned in future.

In 2006, this work will focus on developing a model devoted to Persistent Organic Pollutants (POP) in Polyphemus/Polair3D.
Miscellaneous

In order to simulate long-lived species (such as mercury) and to take into account the impact of other anthropogenic sources of emissions in the northern hemisphere, the development of a prototype hemispheric version of Polair3D has been initiated (Denis Wendum). This is based on particularly simple modifications of the limited area model.

Multiphase modeling

(Group leader: Karine Kata-Sartelet)

During 2005, the activity of the group focused on the development and the validation of two multiphase models that are coupled to the three dimensional host models

Polair3D and Mercure_Saturne. The two multiphase models differ mostly in the discretization of the size distribution of aerosols: lognormal distribution for MAM (Modal Aerosol Model) and size-resolved distribution for SIREAM (Size Resolved Aerosol Model).

PAM project

The works devoted to multiphase modelling (water/gas/aerosols) have been done in the framework of the PAM project (Multiphase Air Pollution), funded by the French research program Primequal/Predit.

The development and the validation of the models MAM and SIREAM for modeling aerosol dynamics by condensation/evaporation, nucleation and coagulation has ended (Edouard Debry and Karine Kata-Sartelet).

Further developments concerned the aqueous phase of aerosols by coupling to SIREAM the cloud model VSRM (Variable Size-Resolved Model) written at CMU by Kathleen Fahey, wet deposition and the influence of the acidity of cloud, heterogeneous reactions at the surface of aerosols, volumic emissions. Coupling MAM and SIREAM to three-dimensional host models also required special attention to numerical problems such as mode merging/splitting in MAM to force modes to be of distinct size ranges throughout the simulations, and redistribution of aerosol sizes on a fixed grid for SIREAM.

The 3D chemistry transport model Polair3D, coupled to the multiphase models SIREAM, has been validated by comparison to data at continental scale over Europe (Kathleen Fahey), over Asia (Karine Kata-Sartelet), at regional scale over Greater Paris (Marilyne Tombette), over Marseille in the framework of the ESCOMPTE campaign (Mohammad Taghavi) and over Lille (Rémy Lagache). Polair3D-MAM has been validated by comparison to data at regional scale over Tokyo (Karine Kata-Sartelet).

The MICS project

At continental scale over Asia, Polair3D-SIREAM participated, thanks to a collaboration with CRIEPI (Central Research Institute of Electric Power Industry), to the phase 2 of MICS (Model InterComparison Study) Asia. Eight teams participated to MICS Asia phase II, which aimed at having a common understanding of model performance and uncertainties in Asia. The study focused on transport and deposition of sulfur, nitrogen compounds, ozone and

aerosols in East Asia for March, July, December 2001 and March 2002.

Local scale

At local scale, Polair3D-MAM is used to reproduce the quick growth of ultrafine particles at the vicinity of roads (Bastien Albriet, Stéphanie Lacour).

MAM was also coupled to the model MERCURE-SATURNE for a more detailed study.

Extension to other applications

For "aircraft" particles, a project coordinated by ONERA, started at the end of 2005 for the modeling of soot (Stéphanie Lacour). This project is funded by Primequal/Predit.

In the framework of a project with CEA, models of aerosol resuspension have been studied (Stéphanie Lacour). This preliminary work leads to a synthesis of available models, parametrisations and measured data to be used by the IAEA (International Atomic Energy Agency) for its Handbooks.

Inverse modeling / Data assimilation

(Group leader: Marc Bocquet)

The ADOQUA (Data Assimilation for Air Quality) cooperative action from INRIA has been accepted. ADOQUA promotes scientific exchange between three projects CLIME (INRIA/ENPC), ASPI (INRIA) and IDOPT (INRIA). A postdoctoral fellow, Lin Wu (previously in the IDOPT project, INRIA, Grenoble), will implement both variational and sequential data assimilation techniques using the CTM Polair3D, and compare the merits of both approaches. He will also work on theoretical questions in data assimilation, such as the effects of non-linearities in air quality data assimilation (main topic of ADOQUA).

From the scientific point of view, several new subjects have been tackled. Ensemble methods for air quality forecast [Mallet, Sportisse] which explores learning strategies for a better forecast is the natural outcome of Vivien Mallet' Phd Thesis. A research in network design for air quality is about to start with the PhD work of Rachid Abida under the supervision of Marc Bocquet (ENPC/IRSN support). First experiments in inverse modeling of radionuclides at regional scale have been investigated using both synthetic and real data [Krysta, Bocquet].

Several projects have been carried out from past year and a few of them concluded:

- Inverse modeling of the ozone precursors at regional scale with a specific study over Greater Lille [Quélo, Mallet, Sportisse];
- Sensitivity analysis and inverse modeling for mercury over Europe [Roustan, Bocquet];
- Entropy-based methods for the inverse modeling of tracer source [Bocquet];
- Inverse modeling of an accidental radionuclide release in the surroundings of a power plant (data assimilation on the Bugey nuclear power plant wind tunnel experiment) [Krysta, Bocquet, Sportisse].

A "young researchers" project has been submitted to the Research National Agency (ANR). The goal of this project is to encourage (mainly financially) a team of a few young researchers to invest into an innovative research project. Our project mainly involved Marc Bocquet (PI), Vivien Mallet and Bruno Sportisse, but also researchers from INERIS and IRSN. The two lead topics that have been proposed are "Network design" and "Ensemble forecast in air quality". The project has eventually been rejected in November. The (surprising) argument invoked was that the team was already well known in the two topics.

An ESA project (Metitop) has been retained in order to investigate the use of satellital data for tropospheric chemistry.

Teaching activities

CEREA is involved in the teaching activities at Ecole Nationale des Ponts et Chaussées. This includes courses devoted not only to applications (Air Pollution) but also to academic fields (Applied Mathematics). CEREA is also active in teaching activities at ENSTA with two courses: one devoted to Computational Physics for geophysics, one devoted to data assimilation.

CEREA is implied in the animation of the Teaching Department ENPC/VET through Vincent Pircher.

CEREA is also involved in the teaching program of Mastère TRADD with a course devoted to Air Pollution and Transport. Some courses (Atmospheric Modeling) have been given in Research Master SGE.

International collaborations

CEREA has welcome some foreign researchers to promote collaborative projects, such as Jorgen Brandt (NERI, Denmark) or Stefano Galmarini (JRC, Italy).

CEREA has begun a participation in the European project NEEDS devoted to Impact studies and Cost-Benefit Analysis of Air Pollution Externalities. This project will promote collaborative works with EMEP/West and IER Stuttgart.

The collaboration with EHTP (Morocco) has been strengthened by a master thesis of ENPC (Fanny Rauwell) and a visit of Jaouad Boutahar, head of a new EHTP laboratory, CERMAI.

A joint project with CRIEPI (Center Research Institute for Electric Power Industry, Japan) has been led by Karine Sartelet (with more than 8 months in Japan). This concerns Air Quality modeling over Great Tokyo with Polair3D and the participation in the MICS-Asia exercise.

CEREA has developed relations with the CMM of Santiago de Chile and Meteo Chile, with topics devoted to inverse modeling of pollutants and Air Quality forecast (mission of Ricardo Alcaful, Meteo Chile at CEREA). This work is supported by CONYCIT/INRIA and is part of the CLIME project.

A common project has been initiated with GMD First (Berlin, Germany) for air quality forecast and data assimilation, Airgrid, devoted to air quality modeling and gridding techniques. This work is part of a PROCOPE french/german program and is inserted in the CLIME project.

CEREA has also a cooperative work inside the CAMP program (Comprehensive Atmospheric Modeling Program) of Georges Mason University (USA). This concerns short-scale dispersion and is led by Bertrand Carissimo (visit at GMU).

The joint project with IIT Delhi (Center of Atmospheric Sciences, Pr. Maithilis Sharan) has been strengthened with a two-weeks visit of J.P Issartel in India.

Personnel

Scientific Staff

ALBRIET Bastien (*)
BOCQUET Marc
BOUTAHAR Jaouad (@)
BOUZEREAU Emmanuel (#)
CARISSIMO Bertrand
DEBRY Edouard (**)
DEMAEL Emmanuel (*)
DUPONT Eric
FAHEY Kathleen (**) (#)
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LAGACHE Rémy (*)
LAPORTE Damien (*)
MALLET Vivien (*)
MILLIEZ Maya (*)
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Master thesis

BORDAS Christelle (ENSTA)
JUHEL Bénédicte (Centrale Nantes)
NJOMGANG Hervé (ENSTA)
PORCHET Adélaïde (ENSTA)
PUERTA Julien (Centrale Marseille)
RAUWEL Fanny (ENPC)

Technical staff

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Teaching activities

Air Pollution, ENPC.

Bruno SPORTISSE, Stéphanie LACOUR.

TRADD Mastère (Air Pollution and Transport), ENPC.

Stéphanie LACOUR, Bruno SPORTISSE.

Applied Mathematics, ENPC (1st year).

Bruno SPORTISSE.

Atmospheric Environment, ENPC (3rd year).

Vincent PIRCHER.

Data assimilation and inverse modeling, ENSTA.

Bruno SPORTISSE, Marc BOCQUET, Vivien MALLET.

Computational Physics for Environment, ENSTA.

Bruno SPORTISSE, Vivien MALLET.

Atmospheric Environment, Centrale Marseilles.

Bertrand CARISSIMO.

Atmospheric Modeling, Master Recherche SGE, Option AQA.

Bertrand CARISSIMO, Luc MUSSON-GENON, Edouard DEBRY.

Master thesis Ecole Polytechnique (PSC Fluid Mechanics).

Stéphanie LACOUR.

Publications

Articles accepted or published

D. Quélo, V. Mallet, B. Sportisse.

Inverse modeling of NO_x emissions at regional scale over Northern France. Preliminary investigations of the second-order sensitivity. Accepted for Journal Geophysical Research.

K. Sartelet, H. Hayami, B. Albriet, B. Sportisse.

Development and preliminary validation of a Modal Aerosol for tropospheric chemistry: MAM. Accepted for Aerosol Science and Technology.

D. Quélo, B. Sportisse, O. Isnard.

Data assimilation for short range atmospheric dispersion of radionuclide: a case study of second-order sensitivity. Journal of

Environmental Radioactivity. Vol.84, Issue 3, p. 393-408.

V. Mallet, B. Sportisse.

A comprehensive study of ozone sensitivity with respect to emissions over Europe with a chemistry-transport model. Journal Geophysical Research, 100, D22 (2005).

V. Mallet, B. Sportisse.

Uncertainty in a chemistry-transport model due to physical parameterizations and numerical approximations: an ensemble approach for ozone modeling. Accepted for Journal Of Geophysical Research.

M. Bocquet.

Grid resolution dependence in the reconstruction of an atmospheric tracer source, Nonlinear Processes in Geophysics, 12, p. 219-234 (2005).

M. Bocquet. Reconstruction of an atmospheric tracer source using the principle of maximum entropy. I: Theory. Quarterly Journal of the Royal Meteorological Society, 131, part B (610), p. 2191 (2005).

M. Bocquet.

Reconstruction of an atmospheric tracer source using the principle of maximum entropy. II: Applications. Quarterly Journal of the Royal Meteorological Society, 131, part B (610), p. 2209 (2005).

E. Debry, B. Sportisse.

Reduction of the condensation/evaporation dynamics for atmospheric aerosols: Theoretical and numerical investigation of hybrid methods. Accepted for Journal of Aerosol Science

J.P. Issartel.

Emergence of a tracer source from air concentration measurements, a new strategy for linear assimilation. ACPD vol 5-249, 2005, p 249-273.

Submitted articles

V. Mallet, B. Sportisse.

Toward ensemble-based air-quality forecasts. In revision for Journal Geophysical Research.

Y. Roustan, M. Bocquet.

Sensitivity analysis for mercury over Europe. In revision for Journal Geophysical Research.

Y. Roustan, M. Bocquet.

Inverse modeling for mercury over Europe. In revision for Atmospheric Chemistry and Physics.

E. Bouzereau, L. Musson-Genon, B. Carissimo.

On the definition of the cloud water content fluctuations and its effects on the computation of a second-order liquid water correlation. Submitted to Journal of Atmospheric Sciences.

M. Krysta, M. Bocquet.

Source Reconstruction of an Accidental Radionuclide Release at European Scale. Submitted to Quarterly Journal of the Royal Meteorological Society.

M. Krysta, M. Bocquet, B. Sportisse and O. Isnard.

Data Assimilation for Short-range Dispersion of Radionuclides: An Application to Wind Tunnel Data. Submitted to Atmospheric Environment.

M. Milliez, B. Carissimo.

Numerical simulations of pollutant dispersion in an idealized urban area, for different meteorological conditions. Submitted to: Boundary-Layer Meteorology (UAQ 2005 special issue).

E. Debry, B. Sportisse.

Numerical simulation of the General Dynamics Equation (GDE) for aerosols with two collocation methods. Submitted to Applied Numerical Mathematics.

E. Debry, B. Sportisse.

Solving aerosol coagulation with size-binning methods. Submitted to Applied Numerical Mathematics.

Articles in French

Y. Roustan, M. Bocquet, L. Musson-Genon, B. Sportisse.

Modélisation du mercure, du plomb et du cadmium à l'échelle Européenne. Submitted to Pollution Atmosphérique.

Bruno Sportisse.

Partenariat recherche publique/entreprise: l'exemple du CERE, Laboratoire Commun ENPC/EDF R&D In "Management de la recherche publique", Rémi Barré Ed.

Proceedings

M. Taghavi, K. Fahey, H. Foudhil, B. Sportisse.

Modeling aerosols with the POLAIR3D/SIREAM model on the mesoscale over an urban area in south-eastern France (ESCOMPTE campaign). European Aerosol Conference, Belgium. September 2005.

Y. Roustan, M. Bocquet, L. Musson-Genon, B. Sportisse.

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E. Demael, B. Carissimo.

A comparison of Eulerian CFD with Gaussian Plume simulations of Prairie Grass Dispersion Experiments 9th annual George Mason University Conference on Atmospheric Transport and Dispersion Modeling, Fairfax, USA, July 18-20 2005.

M. Taghavi, L. Musson-Genon.

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M. Taghavi, L. Musson-Genon.

Intermediate species: does chemistry work in a same way in all models? The Sixth ESCOMPTE Workshop, 2-4 February 2005, Marseille.

M. Bocquet and M. Krysta.

Inverse Modeling of Passive Atmospheric Tracers Using Entropy-based Methods: Methodological Aspects, 2005. Proceedings of the Workshop CEA-EDF-INRIA: Data assimilation and inverse modeling in geosciences. F.-X. Le Dimet and B. Sportisse Eds.

M. Krysta, M. Bocquet and D. Quélo.

Source Reconstruction for Accidental Releases of Radio-elements. Proceedings of NATO Advanced Research Workshop, Tabakhmela, Georgia, 2005.

K. Fahey, E. Debry, H. Foudhil, B. Sportisse.

Proceedings of Gloream 2004. The incorporation of Aerosol processes in Polair3D.

J. Boutahar, B. Sportisse.

Reduction methods and uncertainty propagation: Application to a Chemistry-Transport Model. Proceedings of the TAM/TAM Conference.

M. Tombette, K. Fahey, E. Debry, B. Sportisse.

Aerosol modeling at regional scale: a sensitivity study with the Polyphemus platform. Gloream 7-9 September, Apeldoorn, Pays Bas.

M. Krysta, M. Bocquet.

Inverting sources of an accidental radionuclide release at continental scale. Gloream 7-9 September, Apeldoorn, Pays Bas.

K. Sartelet, H. Hayami.

MICS. Asia Phase II: sensitivity to the aerosol module. Proceedings of the workshop of the Japanese atmospheric environmental society, Nagoya, Japan, 6-9 September 2005.

K. Sartelet, H. Hayami, B. Sportisse.

Application of Polair3D to the model inter-comparison study MICS-Asia Phase II for March 2001. Proceedings of MICS Asia 7th workshop, IISA, Laxenburg, Austria, 14-15 February 2005.

O. Isnard, M. Krysta, M. Bocquet, Ph. Dubiau, and B. Sportisse.

Data assimilation of radionuclides atmospheric dispersion at small scale: a tool to assess the consequences of radiological emergencies. Proceedings of the IAEA Conference. Rio Conference, December 2005.

Reports

Report 2005-1: Rapport d'avancement Convention Cadre CERA/IRSN. B. Sportisse.

Report 2005-2: Rapport d'avancement ADEME: Modélisation de l'impact des métaux lourds, du mercure, et des particules PM2.5, PM10 à l'échelle du continent Européen. Y. Roustan. P.32

Report 2005-3: Application of Polair3D to the modal inter-comparison study MICS-Asia Phase II for March 2001. K. Kata, H Hayami, B. Sportisse. P.5

Report 2005-4: Modeling atmospheric mercury at European scale with chemistry transport Model Polair3D. Proceedings of GLOREAM 2004. Y. Roustan, M. Bocquet, L. Musson-Genon, B. Sportisse. P.11

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Report 2005-7: Mise en place d'une procédure d'imbrication et d'assimilation de données au sein du code Mercure Saturne. B. Juhel. P.81

Report 2005-8: Cours scientifique pour l'environnement – Cours ENSTA 2004-2005. B. Sportisse, V. Mallet. P.72

Report 2005-9: Rapport d'avancement de thèse. Modélisation de la dispersion d'une distribution d'aérosols à petite échelle. B. Albriet. Rapport INERIS. P. 41

Report 2005-10: AtmoData Scientific documentation. Version 1. H. Njomgang, V. Mallet, L. Musson-Genon. P.27

Report 2005-11: Software architecture of an ideal modeling platform in air quality. A first step: Polyphemus. V. Mallet; D. Quélo, B. Sportisse. P.13

Report 2005-12: Data processing and parameterizations in atmospheric chemistry and physics: the AtmoData library. V. Mallet, B. Sportisse. P.14

Report 2005-13: Uncertainty in chemistry transport models due to physical parameterizations and numerical approximations: an ensemble approach. V. Mallet, B. Sportisse. Preprint article submitted to JGR. P.14

Report 2005-14: Inverse Modeling of NO_x Emissions at regional scale over northern France. Preliminary investigation of the second order sensitivity. D. Quélo, V. Mallet, B. Sportisse. Preprint article submitted to JGR. P.12

Report 2005-15: Modélisation des aérosols atmosphériques dans Polair3D: Notice d'utilisation des programmes. H. Foudhil. P.14

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Report 2005-18: Reduction methods and uncertainty propagation: Application to a Chemistry-Transport Model. Proceedings of the TAM/TAM Conference. J. Boutahar, B. Sportisse. P.6

Report 2005-19: Modèle eulérien de la dispersion réactive de gaz et de particules en champs proche. S. Lacour. P.31

Report 2005-20: A comprehensive study of ozone sensitivity with respect to emissions over Europe with a chemistry transport model. V.Mallet, B. Sportisse. Preprint article submitted to JGR. P.14

Report 2005-21: Les aérosols organiques secondaires. Vers une intégration du modèle de Griffin/Pun dans Polair3D. B. Albriet. P.11

Report 2005-22: Sensitivity analysis for mercury over Europe. Y. Roustan, M. Bocquet. Preprint article submitted to JGR. P.12

Report 2005-23: Emergence of a tracer source from air concentration measurements, a new strategy for linear assimilation. JP. Issartel. Preprint article submitted to ACPD. P.25

Report 2005-24: Data assimilation for short range atmospheric dispersion of radionuclides: A case study of second-order sensitivity. D. Quélo, B. Sportisse, O. Isnard. Preprint article submitted to Journal of Environmental Radioactivity. P.16

Report 2005-25: Solving aerosol coagulation with size-binning methods. E. Debry, B. Sportisse. Preprint article submitted to Applied Numerical Mathematics P.18

Report 2005-26: Some numerical issues in chemistry-transport models – a comprehensive study with Polyphemus/Polair3D platform. A. Pourchet, V. Mallet, D. Quélo, B. Sportisse. P.171

Report 2005-27: Impact of thermal power plant emission in Marseille. M. Thaghavi, L. Musson-Genon. P.15

Report 2005-28: On the definition of the cloud water content fluctuations and its effects on the computation of a second order liquid water correlation. E. Bouzereau, L. Musson-Genon, B. Carrissimo. Preprint article submitted to JAS. P.16

Report 2005-29: Quelques éléments de paramétrisations du dépôt sec et du lessivage humide pour les runs Tchernobyl de Polyphemus/Polair3D. B. Sportisse. P.35

Report 2005-30: Resuspension de radionucléides. S. Lacour. Rapport CEA. P.66

Report 2005-31: Cours de pollution atmosphérique: ENPC "dispersion locale de polluants". S. Lacour.

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Report 2005-33: Stage de fin d'études. Modélisation du brouillard à l'aide du modèle météorologique de méso-échelle MERCURE. J. Puerta. P.56

Report 2005-34: Rapport de stage scientifique ENPC. Installation et validation d'une chaîne de modélisation et simulation numérique de la qualité de l'air: application à un cas Européen. F. Rauwel. P.68

Report 2005-35: Rapport de stage long. Prévision opérationnelle de la qualité de l'air. H. Njomgang. P.92

Report 2005-36: Rapport d'avancement de thèse. Simulation de la campagne de mesures Prairie Grass à l'aide du code Mercure_Saturne. E. Demael. P.104

Report 2005-37: Toward ensemble-based air-quality forecasts. V. Mallet, B. Sportisse. Preprint article submitted to JGR. P.11

Report 2005-38: Modélisation du champ de vent et de turbulence sur le site CNPE de Cruas avec le Code Mercure_Saturne. E. Dupont, M.L. Courty, B. Carissimo. P.38

Report 2005-39: Rapport de stage ENSTA. Enjeux numériques dans les modèles de Chimie-Transport. A. Pourchet. P.24

Report 2005-40: Inverse Modeling of Passive Atmospheric Tracers Using Entropy-based Methods: Methodological Aspects, 2005. M. Bocquet, M. Krysta. Proceedings of the Workshop CEA-EDF-INRIA: Data assimilation and inverse modeling in geosciences. F.-X. Le Dimet and B.Sportisse Eds. P.25

Report 2005-41: Source Reconstruction for Accidental Releases of Radio-elements, 2005. Proceedings of NATO Advanced Research Workshop, Tabakhmela, Georgia. M. Krysta, M. Bocquet and D. Quélo, P.8

Report 2005-42: Technical notes on parallel Polair3D. V. Picavet. P.11

Report 2005-43: Modélisation du mercure à l'échelle du continent Européen. I. Paramétrisations. Y. Roustan. P.33

Report 2005-44: Modélisation du mercure à l'échelle du continent Européen. II. Simulations. Y. Roustan. P.19

Report 2005-45: Modélisation du plomb et du cadmium à l'échelle du continent Européen. I. Paramétrisations. Yelva Roustan. P.18

Report 2005-46: Modélisation du plomb et du cadmium à l'échelle du continent Européen. II. Simulations. Y. Roustan. P.18

Report 2005-47: Modélisation du mercure, du plomb et du cadmium l'échelle Européenne. Soumis à Pollution Atmosphérique. Y. Roustan, M. Bocquet, L. Musson-Genon, B. Sportisse. P.20

Report 2005-48: Gestion du Code Mercure_Saturne par CVS, H. Foudhil, B. Carissimo. P.29

Report 2005-49: Estimation de la distribution des concentrations horaires annuelles et de leur variabilité à partir d'un nombre limité de simulations. S. Lacour. Rapport CETU. P.35

Report 2005-50: Aerosol modeling at regional scale: a sensitivity study with the Polyphemus platform. Proceedings of GLOREAM 2005. M. Tombette, K. Fahey, K. Sartelet, B. Sportisse. P.9

Report 2005-51: Cours ENSTA. 2005-2006 Calcul Scientifique pour l'Environnement. B. Sportisse, V. Mallet. Décembre 2005. P.86

Report 2005-52: Modélisation de la dispersion des aérosols à petite échelle. B. Albriet. P.36

Report 2005-53: Modélisation des panaches humides. Note de principe pour l'incorporation dans Polyphemus. H. Foudhil, L. Musson-Genon. P.21

Report 2005-54: Partenariat recherche publique/entreprise: l'exemple du CEREAs, Laboratoire Commun ENPC/EDF R&D. B. Sportisse. P.13

Report 2005-55: Numerical simulations of pollutant dispersion in an idealized urban area, for different meteorological conditions. M. Milliez, B. Carissimo. Preprint article submitted to B.L.M. P.46

Report 2005-56: Numerical simulation of the General Dynamics Equation (GDE) for aerosols with two collocation methods. E. Debry, B. Sportisse. Preprint article submitted to Applied Numerical Mathematics. P.22

Report 2005-57: Etat d'avancement de la convention cadre INERIS/CEREAs pour l'année 2005. B. Sportisse. P.5

Report 2005-58: Polyphemus users' Guide. Denis Quélo, V. Mallet, B. Sportisse. P.27

Report 2005-59: A comparison between Eulerian CFD and Gaussian Plume models on prairie Grass dispersion experiment. E. Demael, B. Carissimo. P.40

Report 2005-60: Teaching notes ENSTA, "Méthodes de l'assimilation de données I". M. Bocquet. Décembre 2005. P.88

Report 2005-61: Rapport de stage ingénieur ECN. Etude de la dispersion à petite échelle de polluants atmosphériques autour d'un chantier de rénovation urbaine. N. Rangod.

Textbooks for teaching activities

(Available at www.enpc.fr/cerea as ParisTech courseware)

Air Pollution Modeling (ENPC)
B. Sportisse

Air Pollution and Transport: emission inventories (ENPC)
S. Lacour

Data Assimilation and inverse modeling (ENSTA)
B. Sportisse and D. Quélo (part 1)
M. Bocquet (part 2)

Computational Physics for Environmental Problems (ENSTA)
B. Sportisse and V. Mallet

Theses in progress

B. ALBRIET
Modélisation des aérosols à l'échelle locale et régionale. ENPC.

R. ABIDA
Construction optimale de réseaux de mesure pour la pollution atmosphérique. ENPC.

E. DEMAEL
Modélisation de la dispersion sur un site nucléaire. ENPC.

M KRISTA
Modélisation inverse de la dispersion des radionucléides dans l'atmosphère. Paris 12.

R. LAGACHE
Couplage de modèles pour l'estimation des impacts de la pollution atmosphérique liée aux transports à l'échelle locale. ENPC.

D. LAPORTE
Amélioration de l'estimation du productible éolien en terrain complexe. ENPC.

H. MALAKOOTI
Modélisation de la qualité de l'air dans une "Megacity". Application à Téhéran. ENPC.

M MILLIEZ
Modélisation thermique au sein du modèle Mercure_Saturne. Application à la modélisation de l'environnement urbain. ENPC.

S. QUEGUINER
Modélisation multi-milieux de la pollution atmosphérique. ENPC.

M. TOMBETTE
Modélisation des aérosols à l'échelle régionale. ENPC.

Theses defended

V MALLET 6/12/05
Estimation de l'incertitude et prévision d'ensemble avec un modèle de chimie-transport - Application à la simulation numérique de la qualité de l'air. ENPC.

Y. ROUSTAN 12/12/05
Modélisation de la dispersion atmosphérique du mercure, du plomb et du cadmium à l'échelle Européenne. ENPC.

Contracts

Agreement 2005 EDF R&D
EDF R&D

Agreement 2005 DRAST
S. Lacour.
METLMT

Agreement 2005 IRSN
B. Sportisse, M. Bocquet, M. Krysta, D. Quélo.
IRSN

Agreement 2005 INERIS
B. Sportisse, B. Albriet, V.Mallet, Y. Roustan, H. Schmitt-Foudhil.
INERIS

Suies émises par les avions
S. Lacour.
ADEME (Primequal Predit)

Etude des facteurs de remise en suspension de particules radioactives
S. Lacour.
CEA

Etude de la dispersion réactive au voisinage des tunnels - CETU
S. Lacour.
CETU

Agreement CERE/CRIEPI
K. Kata-Sartelet, B. Sportisse.
CRIEPI (Japan)

PAM project (Primequal-Predit)
B. Sportisse, K. Fahey, K. Sartelet, E. Debry and M. Tombette.

Conferences, seminars, missions

Conferences

- *EGU, European Geophysical Conference, 2005, 24-29 April, Vienna.*

K. Fahey, E. Debry, H. Foudhil, B. Sportisse: "Size-resolved aerosol treatment in Polair3D: Model development and preliminary validation".

Y. Roustan: Poster.

M. Bocquet, Y. Roustan: "Inverse modeling for mercury over Europe".

- *EAC, European Aerosol Conference, 2005, 28 August - 1st September, Ghent - Belgium.*

K. Fahey, E. Debry, H. Foudhil, B. Sportisse: "Incorporation and Validation of Size Resolved Aerosol Processes in Polair3D".

M. Taghavi: "Modeling aerosols with the POLAIR3D/SIREAM model on the mesoscale over an urban area in south-eastern France (ESCOMPTE campaign)".

- *SIAM Geosciences, 2005, 6-12 June, Avignon.*

V. Mallet: "Inverse modeling of emissions in a chemistry-transport model".

M. Bocquet: Organization of the mini-workshop "Inverse modeling in air pollution" and oral presentation.

"Inverse modeling of passive atmospheric tracers using methods based on the maximum entropy principle".

B. Sportisse: Plenary speaker "Some issues for Air Pollution Modeling".

- *GLOREAM, Global and Regional Atmospheric Modeling, 2005, 7-9 September 2005, Apeldoorn, the Netherlands.*

M. Krysta: "Inverting sources of an accidental radionuclide release at continental scale".

M. Tombette: "Aerosol modeling at regional scale: a sensitivity study with the Polyphemus platform".

Others

M. Milliez. Conference on Urban Air Quality (UAQ 5), Valencia, Spain, 29-31 March 2005. Numerical simulations of plume transport in an idealized urban area for different meteorological conditions.

K. Sartelet, H. Hayami, B. Sportisse. 7th MICS Asia workshop, IISA, Laxenburg, Austria, 14-15 February 2005. Application of Polair3D to the model inter-comparison study MICS-Asia Phase II for March 2001.

K. Sartelet, H. Hayami. Workshop of the Japanese atmospheric environmental society, Nagoya, Japan, 6-9 September 2005. MICS Asia Phase II: sensitivity to the aerosol module.

Y. Roustan. EMEP/TFMM Workshop on MSC-E model review, Moscow, Russia, 13-14 October 2005-11-17. Oral presentation.

V. Mallet, B. Sportisse. Workshop ERCIM. Combining observations and ensemble air-quality forecasts.

M. Bocquet. IPAM/SAMSE Workshop, "Mathematical Issues and Challenges in Data Assimilation for Geophysical Systems: Interdisciplinary Perspectives", UCLA, Los Angeles (2005). Poster presentation.

M. Bocquet. 4th WMO Symposium on data assimilation, Prague, Czech Republic (2005). Poster presentation.

M. Krysta. Air, Water and Soil Quality Modeling for Risk and Impact Assessment. NATO Advanced Research Workshop, 16-20 September 2005, Tabakhmela, Georgia.

M. Taghavi, L. Musson-Genon. Impact of thermal power plant emissions in Marseille, Power-Gen Europe Conference, Milan, Italy, 28-30 June 2005.

Main missions

B. Sportisse. Needs Project (Integrated Project, EU), Stuttgart. February 2005.

B. Carissimo. DTRO Workshop. Frankfurt. June 2005

B. Carissimo. Washington. University George Mason. July 2005.

M. Taghavi. Scientific collaboration with Meteo Iran. June & October 2005.

L. Musson-Genon, EDF, Polska,

D. Quélo, EDF, Polska. December 2005.

M. Milliez, European Research Course on Atmospheres Grenoble. January 2005.

V. Mallet, ADOMOCA workshop (INSU/PNCA). Toulouse, December 2005.

Seminars

S. Lacour. Réseau des économistes des transports. Mécanismes de formation de la pollution atmosphérique, Paris, janvier 2005.

B. Sportisse. EDF R&D Spring Generation Seminar, Chatou. 30-31 May. General presentation of CEREAs.

Invited Fellows

Ricardo Alcañuz (Meteo Chile) INRIA/CONYCI project "Environmental forecast". Air quality forecast with Polyphemus/Polair3D. December 2005.

Jaouad Boutahar (EHTP). Air Quality Modeling with Polyphemus/Polair3D. September 2005.

Arthur Wyrwa (University of Science and Technology, Polka). Impact studies with Polyphemus/Polair3D. January 2005.

Jorgen Brandt (NERI, Denmark). May 2005.
Stephano Galmarini (JRC Ispra, Italy). June 2005

Seminars at CEREAs

January, 14, 2005: Clémence Pierangelo, LMD/IPSL, "Télé-détection infrarouge des aérosols: altitude et épaisseur optique des poussières désertiques depuis l'espace".

January 28, 2005: Cathy Clerbaux, Service d'Aéronomie, IPSL, "Monoxyde de carbone : suivi de la pollution par satellite".

March 18, 2005: Carole Bedos, INRA UMR Environnement et Grandes Cultures, Equipe Biosphère-Atmosphère Grignon, "Modélisation des sources/puits de polluants atmosphériques dans le continuum sol-végétation-atmosphère et de leur dispersion à courtes distances".

March 23, 2005: Workshop of the Scientific Network of the French Ministry for Transport (RST Air).

May 9, 2005: Jean-François Vinuesa, University of Minnesota, "Turbulent reacting flows in the atmospheric convective boundary layer".

June 24, 2005: Serge Guillas, Georgia Institute of Technology, "Statistical Diagnostic and Correction of a 2-D Model for the Prediction of Total Column Ozone".

June 27, 2005: Rachid Abida, Météo Maroc.

June 2005. Project meeting of the INRIA Action ADOQA (Data Assimilation for Air Quality).

Members of scientific Committees

L. Musson-Genon: Scientific Committee for Primequal/Predit, Journal "Pollution Atmosphérique", Conseil Supérieur de la Météorologie/Environmental Committee, Cost Action 728 (Atmospheric Dispersion).

B. Sportisse: Comité National des Aides de l'ADEME/Qualité de l'Air, Scientific committee of "Pôle de compétitivité ville et mobilité durable".

B. Carissimo: Cost Action 732 (Quality Insurance and Improvement of Microscale Meteorological models).

Softwares

AtmoPy

AtmoPy, statistical and graphical python library for analysing Chemistry Transport model output concentrations: comparison to observations, comparison between simulations.

V. Mallet, V. Picavet.

AtmoData

Library for data processing and parameterizations in atmospheric chemistry and physics.

V. Mallet, D. Quélo, H. Njomgang.
ENPC

Mam

Modal Aerosol Model for particulate matter dynamics.

K. Sartelet, B. Albriet, B. Sportisse.
ENPC

Siream

Size Resolved Aerosol Model.

E. Debry, K. Fahey, P. Plion, B. Sportisse, M. Tombette.
ENPC

Polyphemus

Modeling system for atmospheric modeling (www.enpc.fr/cerea/polyphemus) V. Mallet, D. Quélo, Z. Arslan, V. Picavet, B. Sportisse.
Polair3D

Chemistry transport model.

D. Quélo, K. Fahey, K. Sartelet, B. Sportisse, M. Tombette.

Spack

Simplified Preprocessor for Atmospheric Chemical Kinetics.

B. Sportisse, P. Plion, R. Djouad (at University of York, Canada)
ENPC

Mercure_Code Saturne

CFD model for the Atmospheric Boundary Layer.

E. Bouzereau, B. Carissimo, E. Dupont, H. Foudhil, S. Lacour, M. Milliez, L. Musson-Genon.
EDF R&D.

List of initials used

ADEME	Agence pour le Défense de l'Environnement et la Maîtrise de l'Energie
CEA	Commissariat à l'Energie Atomique
CEFIPRA	Centre Franco-Indien pour la Promotion de la Recherche Avancée
CEPMMT	Centre Européen de Prévision Météorologique à Moyen Terme
CEREA	Centre d'Enseignement et de Recherche sur l'Environnement Atmosphérique
CETE	Centre d'Etudes Techniques de l'Equipement
CETU	Centre d'Etude des Tunnels
CNFGG	Comité National Français de Géodésie et de Géophysique
CNRS	Centre National de Recherche Scientifique
CONICYT	Comision National de Investigacion Cientifica y Tecnologica de Chile
CRIEPI	Central Research Institute for Electric Power Industry (Japon)
CSTB	Centre Scientifique et Technique du Bâtiment
DRAST	Direction de la Recherche et des Affaires Scientifiques et Techniques du METMLT
ECL	Ecole Centrale de Lyon
EDF R&D	Electricité de France Recherche et Développement
ENPC	Ecole Nationale des Ponts et Chaussées
ENSTA	Ecole Nationale Supérieure des Techniques Avancées
ERCIM	European Research Consortium for Informatics and Mathematics
ESA	European Spatial Agency
GMD FIRST	German National Research Institute for Information Technology
IAEA	International Atomic Energy Agency
INRIA	Institut National de Recherche en Informatique et Automatique
INERIS	Institut National sur l'Environnement et les Risques Industriels et Sanitaires
INRETS	Institut National de Recherche et d'Etude sur les Transports et la Sécurité
IPSL	Institut Pierre-Simon Laplace
IRSN	Institut de Radioprotection et de Sûreté Nucléaire
LISA	Laboratoire Interuniversitaire des Systèmes Atmosphériques (Paris 7, Paris 12, CNRS)
LMD	Laboratoire de Météorologie Dynamique (X-ENS-CNRS)
LSCE	Laboratoire Surveillance du Climat et de l'Environnement (CEA/CNRS) DEA Modélisation, Simulation, Applications à la Physique (X-ENSTA-UVSQ)
M2SAP	Ministère de l'Ecologie et du Développement Durable
MEDD	Ministère de l'Equipement, des Transports, du Logement, de la Mer et du
METLMT	Tourisme
ONERA	Office National d'Etudes et de Recherches Aérospatiales
PNCA	Programme National de Chimie Atmosphérique
PPF	Plan Pluriannuel de Formation
PREDIT	Programme pour la Recherche, le Développement et l'Innovation dans les transports terrestres
PRIMEQUAL	Programme Interministériel d'Etude de la Qualité de l'Air
PROCOPE	Programme d'action intégrée franco-allemand
UMLV	Université de Marne La Vallée
UVSQ	Université de Versailles-Saint Quentin
VET	Département Ville-Environnement-Territoire de l'ENPC