

# **CEREA**

Centre d'Enseignement et de Recherche en  
Environnement Atmosphérique

Research and Teaching Center in Atmospheric  
Environment

Bilan de l'activité de recherche et des résultats  
obtenus en 2004-2008

Summary Report 2004–2008

Joint Laboratory Ecole nationale des ponts et chaussées/Electricité de France R&D  
Laboratoire commun Ecole national des ponts et chaussées/Electricité de France R&D  
<http://www.enpc.fr/cerea/>

**CEREA**

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# Sommaire

## Table of Contents

1.	Rapport scientifique/Scientific report .....	1-1
	Résumé.....	1-1
	Summary .....	1-4
1.1	Overview of CEREA .....	1-7
1.2	Local Scale and Fluid Mechanics .....	1-13
1.3	Air Quality Modeling.....	1-21
1.4	Data Assimilation.....	1-32
1.5	Meteorological Measurements.....	1-44
1.6	Self-evaluation .....	1-51
2.	Production scientifique .....	2-1
2.1	Publications du CEREA.....	2-1
2.2	Publications du Directeur du CEREA.....	2-18
3.	Enseignement et formation par la recherche, information et culture scientifique et technique .....	3-1
4.	Actions de formation permanente.....	4-1
5.	Hygiène et sécurité.....	5-1
6.	Ethique .....	6-1
	Acronyms/Abbréviations .....	7-1

# **1. Rapport scientifique**

## **Résumé**

Le Centre d’Enseignement et de Recherche en Environnement Atmosphérique (CEREA) est un laboratoire qui dépend de l’Ecole nationale des ponts et chaussées (ENPC) ; l’ENPC étant un membre fondateur de l’Université Paris-Est et de l’Institut des Sciences et Technologies de Paris (ParisTech). Le CEREA, créé en 2004, est un laboratoire commun de l’ENPC et d’EDF R&D. Il accueille un projet commun avec l’Institut national de recherche en informatique et automatique (INRIA) depuis décembre 2005, l’équipe-projet CLIME. Le CEREA est ainsi implanté sur trois sites en région parisienne (Champs sur Marne pour l’ENPC, Chatou pour EDF R&D et Rocquencourt pour l’INRIA).

L’activité principale de recherche du CEREA est la modélisation de la qualité de l’air et de la dispersion atmosphérique sur des échelles allant du local au régional. Cette activité inclus les techniques d’assimilation de données et d’images satellitaires et la modélisation inverse. Par ailleurs, le CEREA est actif dans le domaine de l’étude de la couche limite de l’atmosphère (mesures et modélisation) avec des champs d’application comme l’estimation du potentiel éolien.

## **Partenariats**

Le CEREA s’appuie sur deux partenaires stratégiques principaux avec lesquels la collaboration s’est traduite par des contrats pluri-annuels.

- L’Institut de radioprotection et de sûreté nucléaire (IRSN)
- L’Institut national pour l’environnement industriel et les risques (INERIS)

L’IRSN et l’INERIS fournissent un support technique à l’administration pour des études de risque environnemental (nucléaire et chimique ou biologique, respectivement). Ils disposent de cellules de crise et de plates-formes de prévisions et sont en charge d’études d’impact le plus souvent pour les besoins de l’administration. L’apport du CEREA à leurs activités réside dans le développement d’outils de modélisation et la mise en œuvre de nouvelles méthodologies (modèles d’ensembles pour la prévision de la qualité de l’air, assimilation de données pour l’optimisation des réseaux de surveillance).

Le CEREA a créé des partenariats avec divers organismes scientifiques et administratifs :

- Un partenariat avec l’Institut Pierre-Simon Laplace (IPSL) formalisé par un contrat sur 4 ans qui concerne principalement l’activité instrumentale sur le site de mesures SIRTA à Palaiseau, au sud de Paris. L’équipe de mesures du CEREA a déployé ses instruments de mesures au SIRTA début 2006 et a participé à la campagne de mesures ParisFog en 2006/2007.
- Le CEREA participe au réseau sur les études d’impact pour le ministère des Transports.

- Le CEREA a un partenariat avec un Centre d'Etudes Techniques de l'Equipement (CETE Nord-Picardie). Ce projet concerne la modélisation de la qualité de l'air à des échelles régionales mettant l'accent sur l'impact dû aux transports. Le CEREA est membre actif du réseau R2DS (Réseau de recherche sur le développement soutenable, financé par la région de l'Ile de France).
- Le CEREA a contribué à plusieurs projets financés par des programmes de recherche nationaux : le Programme national sur la chimie atmosphérique (PNCA) de l'Institut national des sciences de l'univers (INSU) pour des recherches sur les aérosols et l'assimilation de données, Primequal pour le projet PAM sur la modélisation des aérosols et les suies émises des avions, le projet Atlas de l'Agence nationale de la recherche (ANR) avec l'Ecole normale supérieure d'Ulm et le programme LEFE de l'INSU pour la campagne ParisFog.
- Le CEREA a un partenariat de longue durée avec EDF Polska (la branche d'EDF en Pologne)
- Le CEREA est membre de plusieurs projets européens tels que HEIMTSA et EXIOPOL sur la modélisation intégrée (en particulier à travers des collaborations avec l'université de Stuttgart).
- Le CEREA a aussi des partenariats avec des pays d'Amérique du Sud (STIC-AmSud avec des organismes au Chili et en Argentine) et d'Asie (EMS-Beijing avec l'Académie des sciences de Chine).

## Activités académiques

- Plus de 50 articles publiés dans des revues internationales avec comité de lecture.
- 1 livre sur la pollution atmosphérique
- 12 thèses de doctorat et deux habilitations à diriger des recherches (HDR) ; plusieurs prix ou nominations ont été reçus par des doctorants. Tous les docteurs du CEREA ont publiés leurs travaux de thèses dans des revues internationales avec comité de lecture.
- Plus de 200 heures de cours par an ont été données par des membres du CEREA (à l'Université Paris-Est, à ParisTech et à d'autres institutions). Certains de ces cours en pollution atmosphérique et en modélisation mathématique sont nouveaux et ont été créés par des membres du CEREA.

## Applications et valorisation

- Le CEREA participe à plusieurs projets EDF R&D (en réponse aux attentes des directions opérationnelles d'EDF dans les domaines du nucléaire, du thermique à flamme et de l'éolien). De tels projets incluent par exemple les projets Impact THF et AREA sur les impacts potentiels de centrales thermiques à flamme, le projet DIAMAN sur l'impact potentiel de centrales nucléaires, le projet LIBECIO sur l'énergie éolienne et le réseau EDF R&D sur les incertitudes en modélisation.
- Le CEREA effectue un nombre d'études appliquées avec des partenaires tels que la DTEP (thermique à flamme) et le CIDEN (nucléaire) d'EDF, l'Agence de l'environnement et de la maîtrise de l'énergie (ADEME), le Commissariat à l'énergie atomique (CEA), le Centre d'études des tunnels (CETU), la Délégation

générale pour l'armement (DGA), l'Office national d'études et de recherches aérospatiales (ONERA), l'INERIS, l'IRSN et le Service d'études sur les transports, les routes et leurs aménagements (SETRA).

- La méthode pour la modélisation d'ensemble réalisée au CEREA est actuellement à l'essai pour le système national de prévision de la qualité de l'air (Prév'air) à l'INERIS.
- Les méthodologies développées au CEREA pour l'optimisation de réseaux de surveillance de la pollution atmosphérique ont influencé le déploiement des réseaux de mesures de l'IRSN.
- Des modèles de dispersion atmosphérique du CEREA ont été utilisés pour des études d'impact de plusieurs centres de production thermique d'EDF
- Le système de modélisation de la qualité de l'air du CEREA est l'un des modèles utilisés par l'Académie des sciences de Chine pour la prévision de la qualité de l'air pendant les jeux olympiques de Beijing et est aussi utilisé par Météo Chili..

# **1. Scientific Report**

## **Summary**

The Research and Teaching Center in Atmospheric Environment (CEREA) is a center at École nationale des ponts et chaussées (ENPC); ENPC is a founding member of Université Paris-Est and of the Paris Institute of Technology (ParisTech). CEREA was created in January 2004 as a joint laboratory between ENPC and the Research & Development branch of Electricité de France (EDF R&D). It hosts a joint project with the Institut national de recherche en informatique et automatique (INRIA; the national computer science institute) since December 2005, the CLIME project. CEREA has three locations in the Paris region (ENPC at Champs sur Marne, EDF R&D at Chatou, INRIA at Rocquencourt).

The main research activity of CEREA is air quality and atmospheric dispersion modeling from short-range to long-range scales, including data assimilation, the assimilation of satellite images, and inverse modeling. Research activities are also dedicated to studying the atmospheric boundary layer (notably for applications related to wind power estimates).

### **Key Partnerships**

CEREA has two important strategic partners, with which it has multi-year multi-task agreements:

- Institut de radioprotection et de sûreté nucléaire (IRSN; Agency for nuclear safety).
- Institut national pour l'environnement industriel et les risques (INERIS; Agency for the industrial environment and risk analysis).

IRSN and INERIS are the national technical centers that support the French government for specific environmental risks (nuclear and chemical or biological risks, respectively). Both agencies include forecast emergency centers, which are also in charge of environmental impact studies. The joint projects include model development, and the development of new methods (for air quality forecasting, monitoring network design and environmental impact studies).

CEREA has also other partnerships with various scientific and government organizations:

- CEREA has a joint agreement with the Pierre-Simon Laplace Institute (IPSL), which pertains mainly to meteorological measurements at the observational site (SIRTA) in the southern suburb of Paris at Palaiseau. The measurement team of CEREA has deployed its instrumentation at SIRTA since early 2006 and has participated in the field campaign ParisFog in 2006/2007.
- CEREA participates in the network monitoring of air quality impacts for the French Ministry of Transportation.

- CEREA has a long-term partnership with a Technical Center of the Ministry of Transportation for northern France (CETE Nord-Picardie). The projects address air quality modeling at regional scales with a focus on the impact of transportation. CEREA is an active member of the R2DS network (Research Network for Sustainable Development, funded by the Ile de France region).
- CEREA has also taken part in many projects funded by national public research programs including the National Program for Atmospheric Chemistry (PNCA) for research on aerosols and data assimilation, Primequal for the PAM project devoted to aerosol modeling and a project devoted to aircraft soot, the National Research Agency (ANR) for the Atlas project devoted to machine learning with “Ecole Normale Supérieure d’Ulm”, and the LEFE Program of the National Institute for Geosciences (INSU) for the ParisFog campaign.
- CEREA has a long-term partnership with EDF Polska (the EDF electric utility in Poland).
- CEREA is a member of the European projects HEIMTSA and EXIOPOL devoted to integrated modeling of air quality impacts (especially with IER Stuttgart).
- CEREA has also partnerships with organizations in South America (STIC-AmSud with organizations in Chile and Argentina) and Asia (EMS-Beijing with the Chinese Academy of Sciences).

## **Academic Activities**

- More than 50 articles have been published in international peer-reviewed journals.
- 1 textbook on air pollution
- 12 Ph.D. theses and two certifications to act as a Ph.D. thesis advisor (“Habilitation à diriger des recherches”, HDR) have been completed; several awards or nominations for Ph.D. students. All Ph.D.’s from CEREA have published their work in the peer-reviewed literature.
- More than 200 teaching hours per year are given by CEREA staff (at Université Paris-Est, ParisTech and other institutions). Some of those courses in air pollution and mathematical modeling were created by CEREA staff during the past 4 years.

## **Applications and Technology Transfer**

- CEREA participates in many projects of EDF R&D (related to the requirements of EDF operational departments, for nuclear, thermal and wind power for electricity production). Such projects include for instance the Impact THF and AREA projects (for the impact of thermal power plants), the DIAMAN project (for the impact of nuclear power plants), the LIBECIO project (for wind power production) and the EDF R&D network “Uncertainties”.
- CEREA carries out many applied projects with partners such as the Fossil-Fuel-Fired Generation and Engineering Department of EDF (DTEP, not a part of EDF R&D), ADEME (the French Agency of Energy and Environmental Management), CEA (Agency for nuclear energy), CETU (Research Center for Tunnels), DGA (Ministry of Defense), ONERA (Institute for Aeronautics), INERIS, IRSN, SETRA (a technical center of the French Ministry of Transportation in charge of road management), etc.

- The ensemble method developed at CEREA is currently being tested at INERIS for their national air quality forecasting system.
- The methods developed for monitoring network design at CEREA have influenced the development of monitoring networks implemented by IRSN.
- Atmospheric dispersion models developed at CEREA have been applied at several EDF fossil-fuel fired power plant sites.
- The CEREA air quality modeling system was one of the models used by the Chinese Academy of Sciences to forecast air quality during the Beijing Olympics and is also used by the Chilean national weather service.

# **1. Scientific Report**

This scientific report summarizes the research activities of CEREA. Section 1.1 presents an overview of CEREA. Sections 1.2 through 1.5 describe specific research activities conducted in the four main research areas at CEREA. A self-evaluation is presented in Section 1.6. A list of acronyms used in this report is available at the end of this document.

## **1.1 Overview of CEREA**

### **1.1.1 Organization**

The Research and Teaching Center in Atmospheric Environment (CEREA) was established in 2004 as a research center at École nationale des ponts et chaussées (ENPC; which is a founding member of both Université Paris-Est and the Paris Institute of Technology/ParisTech). CEREA is a joint laboratory between ENPC and the Research & Development Branch of the French electric utility (EDF R&D). It hosts a joint project with the national computer science institute (INRIA) since December 2005, the CLIME project. CEREA has three locations (ENPC at Champs sur Marne, EDF R&D at Chatou, INRIA at Rocquencourt). Figure 1 depicts the organization of CEREA according to the three host organizations.

The main research activities of CEREA are devoted to air quality and atmospheric dispersion modeling from short-range to long-range scales. Research activities are also dedicated to studying the atmospheric boundary layer (notably for applications related to wind power estimates) and the assimilation of satellite images.

A special focus is given to the assessment of environmental impacts of transport and energy production (thermal or nuclear). These activities are connected with the programs of EDF R&D and with research units and technical centers of the French Ministry of Transportation through its Research Directorate.

Key relationships have been developed for specific applications, for example with IRSN for the simulation of the atmospheric dispersion of radionuclides and with INERIS for air quality impact and forecast studies.

As a research laboratory co-funded by a private company (EDF) and a graduate school (ENPC), CEREA has a double focus on:

- Academic activities (exemplified by scientific publications and Ph.D. theses)
- Applied projects with end-users (from impact studies to development of models and methods for environmental forecast or monitoring network design).

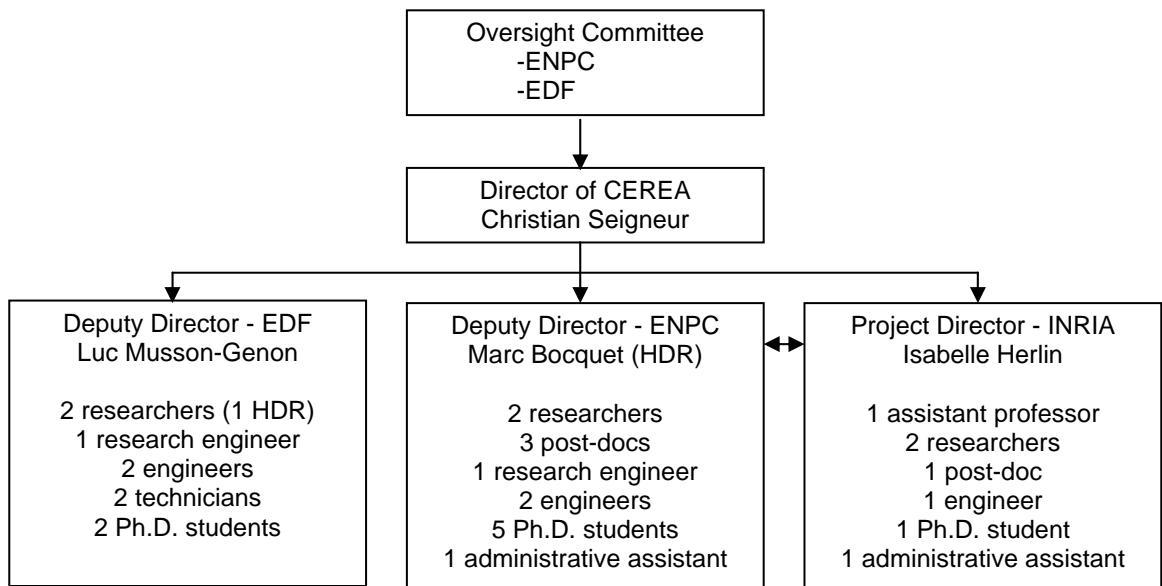


Figure 1. Organization Chart of CEREA

## 1.1.2 Overview of Research Activities

Research activities are organized according to four major areas:

- Atmospheric fluid mechanics and short-range dispersion
- Air quality modeling at urban, regional and continental scales
- Data and image assimilation and inverse modeling (CLIME project)
- Observation of the atmospheric boundary layer

CEREA conducts modeling activities mainly with two numerical models: an atmospheric CFD (Computational Fluid Dynamics) tool, Mercure\_Saturne, for short-range applications (urban air pollution, risk assessment, wind power estimates), and an air quality modeling system, Polyphemus. Polyphemus is a modeling system, which includes different models ranging from short-range dispersion (Gaussian plume and puff models) to long-range dispersion at regional and continental scales (the Chemistry-Transport Models Castor and Polair3D). CEREA researchers develop new parameterizations for physico-chemical atmospheric processes, which are then incorporated in these three-dimensional models.

The resulting models are evaluated by comparisons to available measurements and used for environmental impact studies or forecasting. The research activities devoted to data assimilation (i.e., integrating observations into the modeling process) aim at improving the ability of the models to provide high-quality forecasts and/or performing inverse modeling to optimize model inputs.

The measurement team participates in several campaigns designed to improve the understanding of the atmospheric boundary layer and to support the evaluation of Mercure\_Saturne.

The research activities at CEREA have been extremely productive over the past four years, resulting in:

- More than 50 articles published or accepted for publication in international peer-reviewed journals (see detailed list in Section 2)
- A textbook on air pollution
- 12 Ph.D. theses and two certifications to act as a Ph.D. thesis advisor (“Habilitation à diriger des recherches”, HDR) (see detailed list in Section 2)

Several CEREA Ph.D. students have received awards and nominations:

- Maya Milliez, Best Young Scientist Presentation at the NATO Advanced Study Institute – Flow Transport Processes in Complex Obstructed Geometries, Kyiv, Ukraine, 4-12 May 2004
- Emmanuel Bouzereau, Prix Jacques Gaussens SFEN 2006, Société Française d’Energie Nucléaire
- Vivien Mallet, nominé, Prix de thèse ENPC, 2005
- Maya Milliez, nominée, Prix de thèse ENPC, 2006
- Maryline Tombette, nominée, Prix de thèse ENPC, 2007

### **1.1.3 Overview of Teaching Activities**

CEREA staff organize and teach courses in air pollution and mathematical modeling at Université Paris-Est, ParisTech (ENPC is a founding member of both), and other institutions. More than 200 teaching hours are given by CEREA staff per year. These courses are new courses in air pollution and mathematical modeling created during the past 4 years (see detailed list in Section 3). Course material has been developed by CEREA teachers, which is available on the CEREA web site. As mentioned above, a new textbook was published by Dr. Bruno Sportisse, the first Director of CEREA.

### **1.1.4 Applications and Technology Transfer**

CEREA participates in many projects of EDF R&D (related to the requirements of EDF operational departments, both for nuclear production and thermal production of electricity). This includes for instance the Impact THF and AREA projects (for the impact of thermal power plants), the DIAMAN project (for the impact of nuclear power plants), the LIBECIO project (for wind power production) and the EDF R&D network “Uncertainties”.

CEREA conducts many applied projects with partners such as the Fossil-Fuel Fired Generation and Engineering Department of EDF (DTEP), ADEME (the French Agency of Energy and Environmental Management), CEA (nuclear industry), CETU (Research Center for Tunnels), DGA (Ministry of Defense), ONERA (Institute for Aeronautics), INERIS (Agency for the industrial environment and risk analysis, which is in charge of chemical and biological risks), IRSN (Agency for nuclear safety and radiological protection), SETRA (a technical center of the French Ministry of Transportation in charge of road management), etc.

The practical aspects of those applied CEREA scientific activities can be exemplified by several major operational results:

- The ensemble method for air quality modeling developed at CEREA is currently being tested at INERIS for their national air quality forecasting system.
- The methods developed for monitoring network design at CEREA have influenced the development of monitoring networks implemented by IRSN.
- CEREA atmospheric dispersion models have been applied at various EDF sites.
- The CEREA air quality model (Polypheus) was used for air quality forecasting by the Chinese Academy of Sciences during the Beijing Olympics and is used by the Chilean national weather service.

In addition, INRIA, in collaboration with CEREA, has created two short movies to educate the public on the modeling of air quality.

### **1.1.5 Key Partnerships**

CEREA has two strategic partners:

- IRSN (nuclear safety)
- INERIS (air quality modeling; chemical and biological risks)

Long-term (3 to 5 years) agreements exist with the first two partners, which are the technical centers in support of the government departments in charge of a specific risk (nuclear, chemical or biological, respectively). Both include Forecast Emergency Centers (CASU at INERIS and SESUC at IRSN) also in charge of impact studies. The joint projects are devoted to model development to be shared (especially within the Polyphemus system), to developments of new methods (both for forecast and impact studies) and to dedicated applied studies (see above for examples of technology transfer of CREA scientific products).

CREA has a specific relationship with EDF Polska and the consortium of associated universities, especially AGH (Akademia Górnictwo-Hutnicza) University of Science and Technology, Krakow, Poland. Those research projects address air quality issues in Poland.

CREA has a Joint Agreement with the IPSL Institute. This mainly concerns the observational site (SIRTA) in the southern suburb of Paris at Palaiseau. The measurement team of CREA has deployed its instrumental tools at SIRTA since early 2006 and has taken part in the field campaign ParisFog in 2006/2007. CREA participates in the network devoted to air quality and impacts of the French Ministry of Transportation. The involvement is driven by the Agreement with the Research Directorate of the Ministry (specific to CREA).

CREA has a long-term partnership with the Technical Center of the Ministry of Transportation for northern France (CETE Nord-Picardie). The projects are devoted to air quality modeling at regional scales with a focus on the impact of transportation. CREA is an active member of the R2DS network (Research Network for Sustainable Development, funded by the Ile de France region). CREA has taken part in many projects funded by public national research programs, including PNCA for aerosols and data assimilation funded by the National Institute for Geophysics (INSU), Primequal for the PAM project devoted to aerosol modeling and a project devoted to aircraft soot, the Atlas project funded by the National Research Agency (ANR) devoted to machine learning with ENS Ulm, and LEFE funded by INSU for the ParisFog campaign.

CREA has also developed several international partnerships. For example, CREA is a member of the European Integrated projects HEIMTSA and EXIOPOL devoted to integrated modeling of air quality impacts (especially with IER Stuttgart). CREA has also participated in an air quality model intercomparison in Asia (MICS Asia). Moreover, the CLIME project includes a strong cooperation with CMM (Chile) and University of Cordoba (Argentina) to establish air quality forecast systems and data assimilation capabilities in Chile and Argentina. This cooperation is currently supported by the research project STIC-AmSud. The objective is the forecast of air quality using data

assimilation techniques in South America. This project involves CMM (Chile), the Chilean weather office (DMC, Chile), the University of Cordoba (Argentina), and the environmental monitoring group of CNEA (Argentina).

### **1.1.6 Financial Data**

Table 1 summarizes the main features of the CEREIA budget for 2004-2007, as presented to the Oversight Committee of CEREIA at the end of each year. The total budget also includes the salaries of the permanent staff. “Others” refers to other sources of funds besides those of EDF and ENPC (contracts, INRIA, etc). Overall, EDF contributes about [40-50] %, the ENPC contributes about [25-30] % and other funding sources contribute about [25-30] %. On average, CEREIA obtains about [500-600] kiloeuros of outside contracts per year, including [200-350] kiloeuros funded by EDF for specific projects and [200-350] kiloeuros funded by other partners and projects. ENPC funding (for traveling expenses, training equipment, etc.) amounts to [70-125] kiloeuros.

Table 1: CEREIA Budget for 2004-2008.

Year	Total budget (k€)	ENPC Contribution	EDF Contribution	Others
2004	1530	46%	43%	11%
2005	1586	30%	45%	25%
2006	1702	28%	50%	22%
2007	1675	30%	45%	25%
2008*	1928	30%	45%	25%

\*Forecast for 2008.

### **1.1.7 Management**

CEREIA is currently led by a Director (Christian Seigneur) and two Deputy Directors (Luc Musson-Genon, EDF, and Marc Bocquet, ENPC). From 2004 to 2007 the CEREIA was managed by Bruno Sportisse (Director) and Luc Musson-Genon (Deputy Director). The joint project with INRIA (CLIME) is led by Isabelle Herlin, INRIA, Project Director, and Marc Bocquet, ENPC, Deputy Project Director.

Meetings for the whole staff are organized 4 to 6 times per year. Each research group organizes, when necessary, its own meetings.

The Oversight Committee of CEREIA includes 3 representatives each from EDF and ENPC. The Director, the Deputy Directors and the CLIME Project Director attend the meetings of the Oversight Committee. It meets twice a year: in July for the presentation of a Progress Report and in December for the presentation of the results for the past year

and a forecast of the activity for the coming year. Four reports are then submitted for approval by the Oversight Committee: the Activity Report of CEREA and the Budget Report for the past year, a Program Report and a Budget Report for the coming year.

The operation of this joint laboratory is governed by a contract between ENPC and EDF R&D. The first contract covered 2004-2007, the current contract covers 2008-2011. At the end of each quadrennial period, an evaluation of CEREA past activities and future plans is conducted by an international scientific committee; the resulting report by this scientific committee is then submitted to the scientific committees of EDF and ENPC.

## 1.2 Local Scale and Fluid Mechanics

The activities in this research area are related to the interests of the French Ministry of Transportation (urban pollution) and those of EDF (dispersion at an industrial site). They mainly rely on the development and application of a numerical model, Mercure\_Saturne (developed at and maintained by EDF). This code is based on a general purpose computational fluid mechanics (CFD) tool, CodeSaturne. In this framework, the team adapts or develops parameterizations suitable for the atmospheric environment (roughness wall law, drag urban canopy parameterizations, transport equation for concentration and fluctuations, microphysical cloud scheme, atmospheric radiative scheme, chemistry model, aerosols model...).

In 2006, in addition to efforts in pre- and post-processing (creation of mesh for complex terrain and buildings), a new scheme for atmospheric radiative transfer in the presence of buildings was developed. In 2007, through the new open source version of code Saturne 1.3, the atmospheric part Mercure evolved to a more integrated version in Saturne in order to facilitate future developments and maintenance. This modeling activity is strongly connected with the atmospheric measurement team at CEREA for the observation of the atmospheric boundary layer (Section 1.5).

### Cloud Scheme for Cooling Tower Plume and Fog

A detailed microphysical parameterization for water was first developed in Mercure\_Saturne (Ph.D. thesis of Emmanuel Bouzereau, 2004) for the simulation of cooling tower plumes. This parameterization describes the liquid water content in clouds and rain. The droplet size distribution is also predicted. This parameterization was extensively validated by a detailed comparison with data from the field campaign around the cooling tower of Bugey (in the 1980s), which included aircraft measurements in the plume (Figure 2). A second application is the simulation of orographic precipitation with data available in the literature. This work was performed with the former version of Mercure\_Saturne and the transition to the new unstructured version was done as an additional task and the results successfully compared.

The warm cloud microphysical scheme previously developed for the simulation of cooling tower plumes was then applied to a first case of fog development and dissipation

observed during ParisFog experiment in the winter 2006-2007. These first simulations were performed in one dimension and showed that the scheme, that can also predict the droplet distribution, is suitable for both applications. The nucleation, settling/deposition and accretion parameterization have been improved in order to take into account fog and aerosols specificities on SIRTA site (Section 1.5). A data assimilation method based on a nudging technique has been implemented. Three dimensional simulations are ongoing.

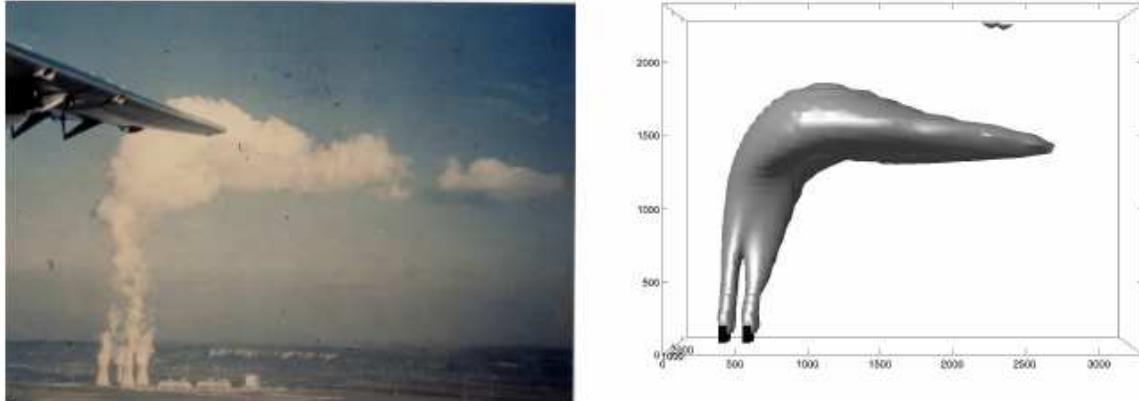


Figure 2. Water droplet plume from cooling towers at the Bugey power plant. Left: plume photograph taken from the measurement airplane. Right: iso-surface of liquid water concentration from numerical simulations using Mercure\_Saturne (Ph.D. thesis of E. Bouzereau).

References: Bouzereau et al. (ACL-17); Bouzereau (TH-4)

## Dispersion in the Urban Environment

The topics related to atmospheric dispersion in an urban environment were developed through the Ph.D. thesis of Maya Milliez (2006), which aimed at simulating dispersion in an atmospheric environment with obstacles. A first part was the simulation of the Mock Urban Setting Test (MUST) experiment in the USA (Figure 3). An array of shipping containers (12 rows by 10 columns) was representing an idealized urban quarter. A special unstructured grid was set up to simulate these 120 buildings with a still reasonably sized grid of around one million cells. The results obtained with Mercure\_Saturne were compared to the available observational data for several days and good comparison statistics were obtained. An original aspect of this work was the ability to simulate fluctuations of concentrations through an additional Eulerian transport equation for the variance of concentrations, which also compares reasonably well with the observations of MUST. In the course of this work, some tools for handling unstructured meshes were developed.

The last part of this Ph.D. thesis was devoted to the simulation of thermal and radiative effects in complex geometries of the urban canopy in order to take into account both the solar and infrared radiations in a complex geometry (buildings and street canyons). It is derived from numerical techniques used for combustion and adapted for atmospheric

applications. The numerical results were compared to simple experiments and existing measurements giving the variation of albedo as a function of solar zenith angle and to temperature measurements taken on several container sides during the MUST experiment

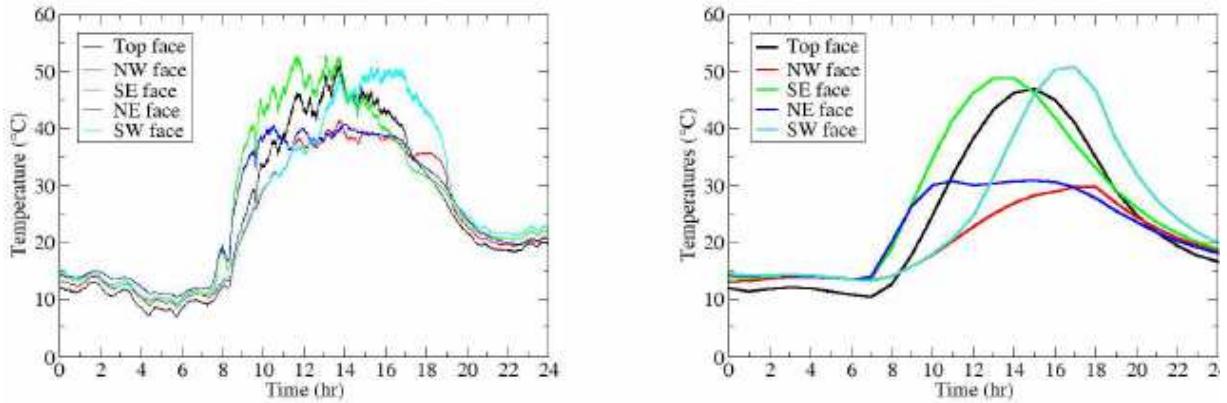


Figure 3. Diurnal time evolution of the temperature of various faces of a container during MUST. Top left: observations during the MUST experiment. Top right: numerical simulations using the new atmospheric 3D radiative scheme developed in Mercure\_Saturne for the urban canopy (Maya Milliez, Ph.D. thesis, 2006). Bottom: experimental set-up of MUST (Mock Urban Setting Test Experiment, 25 September 2001).

References: Milliez et al. (ACL-25, ACL-38), Milliez (TH-8)

## Dispersion around an Industrial Site

In the Ph.D. thesis of Emmanuel Demael (2007), the first objective was to compare Mercure\_Saturne with models which are typically used for simulating dispersion from industrial sources (Gaussian plume models). The differences were quantified and explained, in particular for the behavior very near the source (Figure 4).

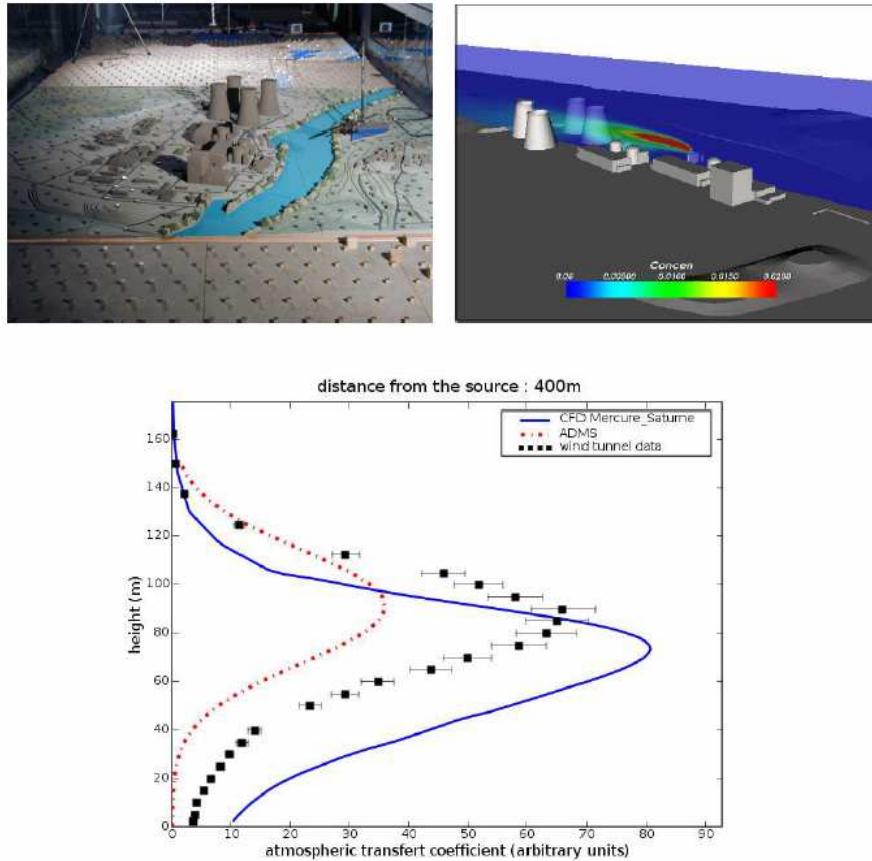


Figure 4. Top left: view of the wind tunnel experiment (ECL/IRSN). Top right: simulated concentration field. Bottom: comparison of concentration profiles between wind-tunnel data, MercureSaturne and ADMS 3.0 simulations for the release on the chimney (vertical profile at 400 m in built-up area) (Emmanuel Demael, Ph.D. thesis).

Subsequent work addressed the simulation of two actual industrial sites, including buildings and topography, for which the mesh and simulation domain were constructed. One of these sites is in the center of France with moderate topography; the other one is on the coast of Normandy and constructed on the foot of a cliff and is therefore characterized by a very complex topography. For these industrial sites detailed wind tunnel measurements are also available and are used for the comparison for both the dynamical fields (wind and turbulence) and the dispersion fields (concentrations and fluctuations). Several sensitivity studies have been performed. A rigorous uncertainty

analysis on the simulation results for the concentration values using Monte Carlo techniques has also been performed (to be used for impact studies of actual industrial sites).

References: Demael and Carissimo (ACL-39), Demael (TH-10)

## Wind Potential Estimates (Ph.D. thesis of Laurent Laporte)

Most current operational studies of wind potential estimates use very simple linearized models, which fail in complex terrain and along the coast where local circulations induced by the thermal contrast can develop. Our goal was to develop a new methodology based on the use of an atmospheric CFD code. First, the classical case of the Askervein hill has been carried out to check the modeling results. Then, a program including both measurements and simulations with Mercure\_Saturne has been initiated in 2007 on a complex terrain located in the south of France. The field campaign involving several meteorological masts and sodars is presented in more detail in Section 1.5. Simulations were forced with hourly ALADIN analyses and forecasts. Examples of maps of wind speed and turbulent kinetic energy at hub height (80 m) are shown in Figure 5, for a North-West incoming wind. These maps averaged over a long period (at least one year) can help in the definition of the lay-out of the turbines. In order to simulate such a long period, a clustering method has been applied to the ALADIN outputs of the year 2007. The simulation of the clusters representative situations is under way. Thus, a first wind resource estimate with Mercure\_Saturne will be obtained and compared to the measurements and to the operational linear code WAsP.

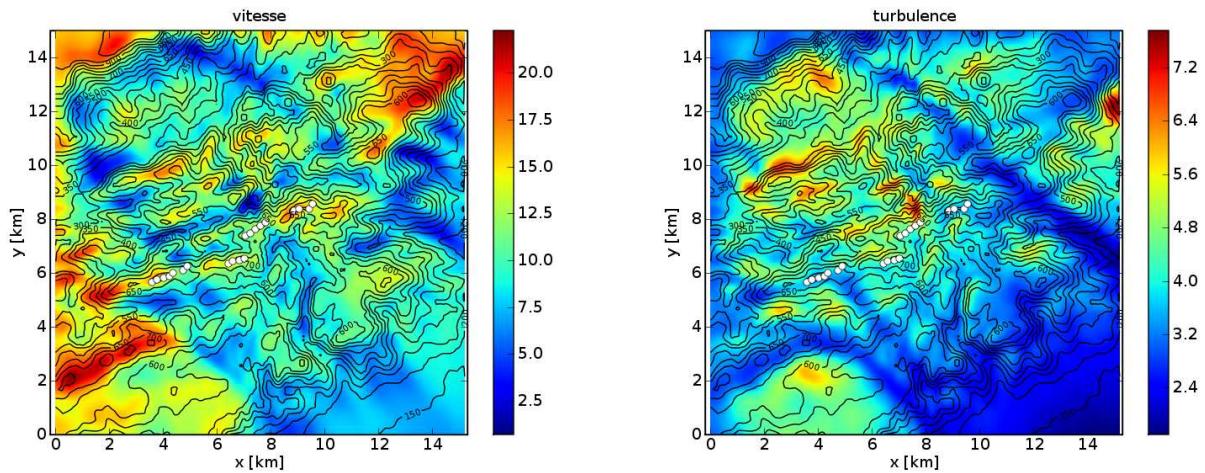


Figure 5. Wind speed (left, in m/s) and turbulent kinetic energy (right, in  $\text{m}^2/\text{s}^2$ ) at 80 m above ground level (hub height), for a North-West incoming wind. Small white circles represent the position of future wind turbines (Laurent Laporte Ph.D. Thesis).

An additional objective of this work was to better quantify the effect of "mask" created by wind turbines, which can lead to a large uncertainty on the energy production estimate and an increase of the mechanical loads on the turbines, especially in very large offshore wind farms. The masking effect was treated in Mercure\_Saturne by ways of a drag within

the flow. This drag term is calculated according to the Blade Element Momentum theory using geometric and aerodynamic characteristics of the blades. A comparison with wind tunnel measurements has been performed for a large multi-MW turbine in the framework of a partnership with Polytech'Orléans. A globally good agreement is found although some differences in the magnitude of the speed deficit still need to be investigated.

References: Laporte et al. (AFF-59), Laporte (AP-159)

## **Short-Range Dispersion of Reactive Air Pollutants Emitted from Vehicles**

A chemical mechanism describing the fast atmospheric chemical reactions was coupled to Mercure\_Saturne. The focus is on the NO/NO<sub>2</sub> conversion just after emission. This reactive version of Mercure\_Saturne was compared to data measured in a Copenhagen street, Jagtveg Street. This data base has already been used for box models. The results were satisfactory and the reactive version of Mercure\_Saturne clearly led to a much better estimation of chemical concentrations in general when the chemical regime is standard (just a few cases were found anomalous).

Additional diagnostics were performed. Computed spatial average concentrations in the street canyon were found to be close to single point values found next to the windward side. The NO<sub>2</sub> roof fluxes were found to be very sensitive to ozone background concentrations. The Mercure\_Saturne reactive version is currently used to study the efficiency of new building materials proposed to reduce NO<sub>2</sub> pollution near busy streets (some comparisons have been performed with data from the PICADA experiment).

In addition, for the simulation of the formation of very small particles at the exhaust of a vehicle, a coupling has been performed between Mercure\_Saturne and the Modal Aerosol Model (MAM). The results (Figure 6) show the evolution of the spectrum of the particle size distribution as a function of the distance from the tail pipe. Several meteorological conditions (winter/summer) and different humidity have been studied. A sensitivity analysis showed that semi-volatile organic compounds can significantly contribute to the growth of nanoparticles by condensation,

References: Albriet and Sartelet (AFF-37, AFF-41), Albriet (TH-9)

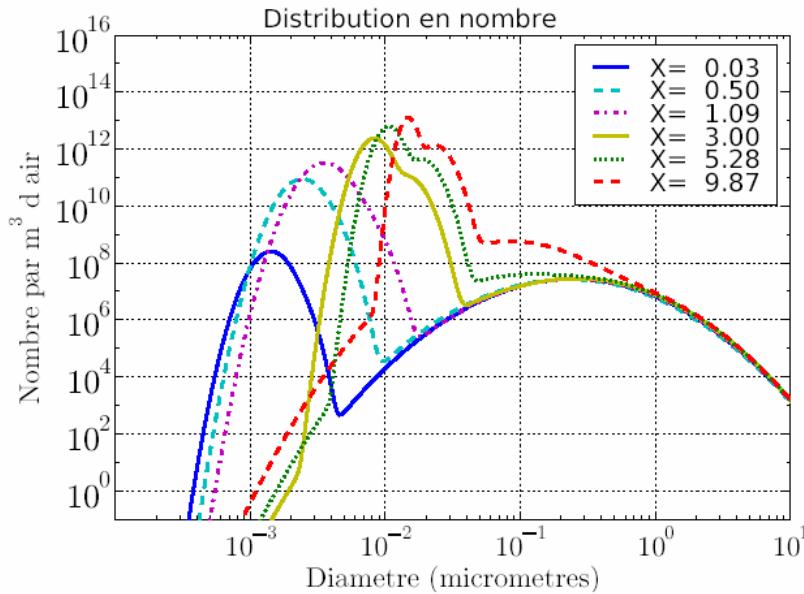


Figure 6. Evolution of the number concentration of PM1 as a function of distance from the vehicle exhaust ( $X$  in m) obtained by numerical simulation by coupling the atmospheric model Mercure\_Saturne et and the modal aerosol model MAM (Bastien Albriet, Ph.D. thesis, 2007)

## Tunnel-Induced Air Pollution

A project was conducted with CETU to assess the pollution induced by tunnels. The flow velocity inside a tunnel fluctuates due to the unsteady forces related to the vehicular flux. Periodic boundary conditions at the tunnel exit were established in order to take into account heavy duty vehicles passing through the tunnel portal. The reactive version of Mercure\_Saturne was used to describe the impact of a tunnel plume. Passive and reactive dispersion results under various pollution conditions were compared to estimate the impact on the NO<sub>2</sub> concentrations. NO<sub>2</sub> is systematically underestimated in the case of passive dispersion, especially when the ozone concentrations are high. The discrepancy between the reactive and the passive models is less pronounced when the ozone concentrations are low. Box models were also employed to give rough estimates of NO<sub>2</sub> concentrations around tunnel portal. The results were taken into account for the "User's Guide of Air Pollution Study for Tunnels" written by CETU.

An alternative approach, based on a short-range version of Polair3D, was developed for impact studies of roads and tunnels. A classification of pollution was proposed in order to distinguish the "background" component and the "local" component. Some strategies were proposed in order to simulate the long-term impact of such infrastructures. Artificial measurements were elaborated with a Gaussian model that simulates the dispersion around a tunnel portal with noisy and variable series of meteorological/emission inputs. The yearly concentrations and its variability are computed from these results at different locations near the emission point.

References: Lacour (AP-18, AP-34)

## **Traffic-Induced Air Pollution**

Impact studies for roads focus on the effects of traffic but few data are available for emissions from road work. Road work, which occurred near a traffic air quality monitoring station in Northern France (Dunkerque), was used as a case study. Data on vehicle flows and work schedule and devices were put together with atmospheric data (concentrations and meteorological parameters) collected by the local monitoring network in order to build a database. In collaboration with the “Laboratoire central des ponts et chaussées” (LCPC, the laboratory of the Ministry of Transportation), some quantitative elements about the atmospheric pollution related to conventional species near a road work place were extracted from this database. Non-parametric regressions were used to select the data suitable for linking air concentrations to emissions. A dispersion model was used to find out the maximal impact on measured concentrations.

Reference: Lacour et al. (AP-148)

## 1.3 Air Quality Modeling

The activities in this research area focus on the development, application and evaluation of mathematical models of air quality. Model development has focused so far mostly on (1) the development of models of the chemistry and physics of atmospheric particulate matter (PM) and (2) the development of a modular modeling platform, Polyphemus. We present first aerosol model development activities; then we describe the development of the Polyphemus modeling system and some air quality model applications.

### Development of MAM and SIREAM

Atmospheric PM consists of solid or liquid particles in suspension in the atmosphere (aerosols) with sizes of a few microns or less. Model applications have been conducted mostly with the three-dimensional grid-based air quality model POLAIR which is part of the Polyphemus modeling system. Two new aerosol models have been developed at CEREA. They differ mainly in the discretization of the size distribution of the particles: log-normal distributions for MAM (Modal Aerosol Model) and size-resolved distribution for SIREAM (Size Resolved Aerosol Model).

The main part of the model development was performed in the framework of the PAM project (Multiphase Air Pollution), funded by the French research program Primequal/Predit (2001-2006) and led by Bruno Sportisse. Apart from the modeling activities at CEREA, the PAM project took part in the LISAIR Campaign in Paris (led by Partick Chazette, LSCE). The development of the models MAM (by Karine Kata-Sartelet) and SIREAM (by Edouard Debry and Bruno Sportisse) first focused on the General Dynamic Equation (GDE) for aerosols, which describes the time evolution of the aerosol distribution in a box under nucleation, condensation/evaporation and Brownian coagulation. The aerosol size distribution is made of four log-normal modes in MAM and of a user-specified number of sections in SIREAM, with diameters typically ranging from 0.01  $\mu\text{m}$  to 10  $\mu\text{m}$ . The assumption of internal mixing is made (to each size corresponds a unique chemical composition). The species are inorganic (on the basis of the thermodynamic model ISORROPIA: sodium, ammonium, sulfate, nitrate and chloride), organic (primary organic aerosols and parameterized representation of secondary organic aerosols with two-product formulations), inert (mineral dust and black carbon) and water. Parameterizations are used to model binary nucleation (sulfuric acid and water) and ternary nucleation (sulfuric acid, ammonia and water). The different processes that influence the aerosol composition and the size-distribution are shown in Figure 7.

References: Sartelet et al. (ACL-9), Debry et al. (ACL-18)

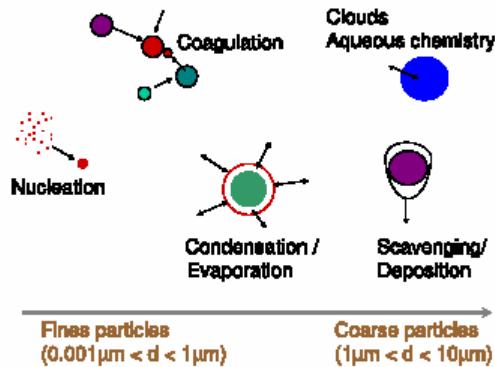


Figure 7. The different processes that influence the composition and the size-distribution of aerosols.

## Numerical Simulation of the Aerosol General Dynamic Equation

Several numerical algorithms have been developed at CEREA for the numerical simulation of the GDE (Ph.D; thesis of Edouard Debry). As the GDE for atmospheric aerosol involves several processes, the splitting strategy is important. Coupled methods are well suited methods to solve aerosol dynamics, nevertheless they usually need a large number of size discretization points to be stable. Figure 8 (left panel) shows the error as a function of splitting time step, for splitting and coupled strategies with different splitting sequences between coagulation and condensation.

In SIREAM, because the coagulation between two size sections does not exactly fall into one size section, one has to redistribute the coagulation product among several size sections. Several possibilities to compute the partition coefficients have been proposed in the literature. The error induced by partition coefficients mainly lies in the upper part of the aerosol size spectrum, leading to a numerical diffusion towards large size sections. Figure 8 (right panel) shows the error as a function of the number of size sections for various kinds of partition coefficients.

In MAM, specific mode merging and splitting were developed to force modes to be of distinct size ranges throughout the simulations (Karine Kata-Sartelet and Bastien Albriet). The importance of mode splitting is stressed in Figure 9, which compares the number distribution during a high-nucleation episode, as computed with MAM (with or without mode splitting) and SIREAM (15 or 50 sections). New algorithms have also been developed for the redistribution of aerosol Lagrangian size sections on a fixed size grid.

References: Debry et al. (ACL-20, ACL-21), Sartelet et al. (ACL-9), Debry (TH-3)

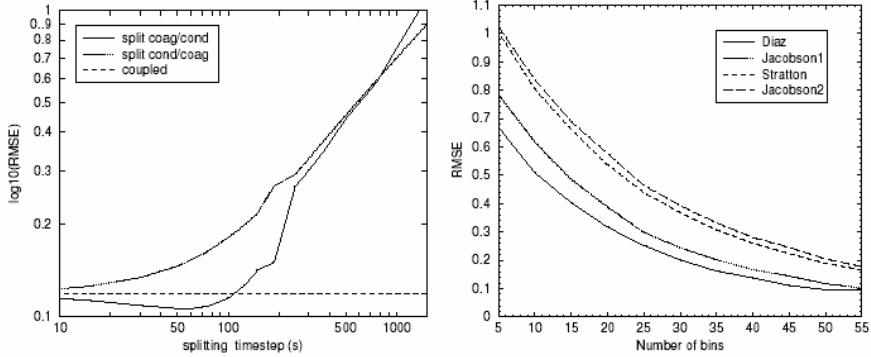


Figure 8. Numerical investigation of the GDE with sectional methods. Left: comparison of splitting and coupled methods for the Collocation/Rosenbrock method (Root Mean Square Error, RMSE, as a function of the splitting timestep). Right: evolution of the RMSE with respect to the number of bins for different partition algorithms.

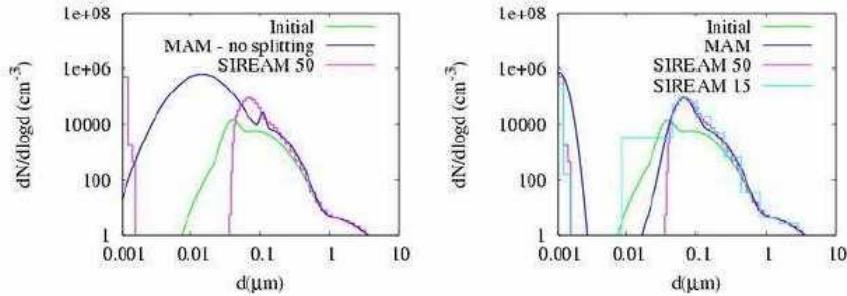


Figure 9. Comparison of the number distribution during a high-nucleation episode with MAM (with or without mode splitting) and SIREAM (15 or 50 sections).

## Hybrid Approaches for Condensation/Evaporation

Condensation/evaporation is a key process governing the aerosol composition and size distribution. Gaseous species may condense onto existing aerosols, or species in the particulate phase may evaporate. This mass transfer between the particulate and the gaseous phases depends on the difference of concentrations of gaseous species far from aerosols and the concentrations of gaseous species at the surface of aerosols (which are assumed to be at local thermodynamic equilibrium with the aerosol internal composition). Mass transfer can be computed dynamically, or by assuming thermodynamic equilibrium between the gaseous species far from aerosols and the internal aerosol composition. As dynamical mass transfer requires a lot of computing time compared to thermodynamic equilibrium and as the assumption of thermodynamic equilibrium may not be accurate for large aerosols, a hybrid approach was developed: thermodynamic equilibrium is assumed for small aerosols and dynamic mass transfer is computed for large aerosols.

References: Debry and Sportisse (ACL-10), Debry (TH-3)

## Modeling of Secondary Organic Aerosols

The modeling of Secondary Organic Aerosols (SOA) is a challenging issue in aerosol modeling because of the large number of chemical species involved and their various interactions among themselves as well as inorganic species present in atmospheric PM. In previous studies over Europe with Polyphemus and the organic module SORGAM, the concentrations of SOA were under-estimated. The development of a new SOA model was conducted by Edouard Debry in collaboration with Christian Seigneur.

The new organic aerosol model includes several significant improvements to the treatment of SOA formation:

- the description of hydrophylic/hydrophobic effects
- the addition of sesquiterpenes and isoprene as new SOA precursors
- the description of polymerization effects
- the addition of semi-volatile organic compounds as SOA precursors

Figure 10 shows the percentage of SOA in PM obtained with the organic module previously used (SORGAM) and with the new module over Europe. The higher concentrations of SOA obtained with the new module are more realistic. The new SOA module has also been tested over the Paris region by comparing simulated organic carbon (OC) concentrations to those measured in the LISAIR campaign. Semi volatile organic compounds (SVOC) emitted from traffic, which are often neglected from emission inventories, were added to the emission inventory used for the Paris region and better agreement between the model and the data was obtained.

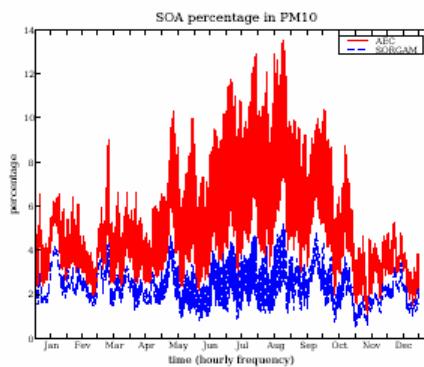


Figure 10. Percentage of SOA in PM over Europe for the year 2001. Polyphemus is runned with two SOA models (AEC in red and SORGAM in blue).

References: Debry and Seigneur (AFF-36), Debry et al. (AFF-39)

## 3-D Parameterizations for Multiphase Models

To couple the three-dimensional (3-D) Chemistry Transport Model Polair3D to the multiphase models SIREAM and MAM, other processes must be taken into account.

Some examples of new parameterizations that were incorporated into Polair3D include dry deposition, below-cloud scavenging, the influence of the acidity of clouds for below-cloud scavenging, in-cloud scavenging and the treatment of emissions. Sea-salt emissions were also parameterized as a function of wind speed. The aerosol liquid water content, which is used to compute the aerosol wet diameters, is parameterized using an updated Gerber scheme. Specific effort was also devoted to the parameterization of in-cloud and below-cloud scavenging for gases. Recently, the parameterizations used for the heterogeneous reaction probability for  $\text{N}_2\text{O}_5$  was updated in order to take into account the aerosol chemical composition, temperature and humidity.

References: Debry (AP-175), Sartelet (AP-108)

## Development of the Polyphemus System

The air quality modeling activities conducted at CEREA cover a wide range of air pollutants (e.g., photochemical pollutants such as ozone and PM, heavy metals such as mercury or lead, persistent organic pollutants, and radionuclides), spatial scales (local to continental) and types of applications (research, impact studies and air quality forecasting). In order to handle such a wide variety of air quality conditions with a single model, CEREA developed a new and comprehensive modeling system, the Polyphemus platform (<http://www.enpc.fr/cerea/polyphemus/>). Polyphemus means “multiple speeches” in classical Greek, which is consistent with the goals of the system, that is, gathering on the same platform:

- several models: with Lagrangian and Eulerian formulations;
- several scales: from the local scale to the continental scale;
- multiple pollutants: passive, radionuclides, photochemical, aerosols, POPs, ...
- processing from many inputs (meteorological models, chemical data);
- many advanced methods: data assimilation, ensemble forecasting, models coupling, ...

It is written as much as possible with modern computer languages (mainly C++), and only perennial and scalable developments are included. Polyphemus is open source, distributed under GNU GPL, well documented (for users and developers), and released with recent updates on a regular basis. “Open” also means that contributions from other teams are welcome. The development consortium includes a core of the three CEREA host organizations, ENPC, EDF and INRIA, and two major supporting partners IRSN and INERIS.

Many joint projects with other teams have already 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 and Health Impact Assessment in the framework of the European projects NEEDS, EXIOPOL and HEIMTSA) or modeling of the short-range dispersion of pollutants (for INERIS and DGA).

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

- Physical parameterizations and preprocessing with the object-oriented AtmoData library (potentially shared with any team involved in atmospheric modeling, whatever the model is);
- High-level drivers of models seen as black boxes (for data assimilation, for coupling, for Monte Carlo simulations, for ensemble runs);
- Numerical models (for instance Polair3D or Castor, a C++ clone of Chimere, but also Gaussian and puff models);
- Post-processing facilities, for instance for statistics and model-to-data comparisons, through the Python library AtmoPy.

One advantage of this structure is the possibility to have a multi-modeling approach through the available parameterizations. This system has been used for numerous applications (itemized below), implying a growing number of teams in joint projects.

Moreover, a training session for the users of Polyphemus was organized in March 2007 (with 13 participants from INERIS, IRSN, CEA, ARIA Technology, University of Lille, Ministry for Transport and EDF/CIDEN). A training session devoted to inverse modeling and data assimilation was organized in June 2007 in Santiago de Chile for South America (with more than 10 participants from Chile, Argentina and Brazil).

Polyphemus is also used in courses at ParisTech (ENPC and ENSTA: “Air Pollution”, “Computational Physics for Environment”, “Data Assimilation and Inverse Modeling”). The improvement of Polyphemus for the ParisTech OpenCourse Ware will be funded by ParisTech for summer 2007.

References: Mallet et al. (ACLN-3, ASCL-1), de Biasi (AP-176)

## Numerical Analysis for Chemistry-Transport Models

Solving the Partial Differential Equations that describe the atmospheric dispersion of atmospheric reactive species is still a challenging issue due to the wide range of timescales and the large dimension of the resulting systems.

A comprehensive study of the numerical issues was investigated for a few real cases (air quality modeling over Europe for summer 2001 and simulation of the Chernobyl accident).

Another specific point is the so-called mass consistency problem related to the off-line coupling between atmospheric dispersion models and meso-scale numerical models that provide meteorological fields such as wind velocity.

References: Mallet et al. (ACL-23), Sportisse et al. (ACL-34)

## Air Quality Forecast

Due to the wide range of uncertainties, a promising approach for air quality forecast is related to ensemble techniques. The Ph.D. thesis of Vivien Mallet (2005) focused on the assessment of the *a priori* uncertainties in the outputs of a Chemistry-Transport Model through Monte Carlo methods and an ensemble approach in PolypheMUS for ozone. The ensemble approach has subsequently been extended to model particulate matter over Europe. The coupling of this ensemble approach to the Prév'air platform for air quality forecasting of INERIS was achieved in 2006. The PolypheMUS system for air quality forecasting has been in operation on the Prév'air platform since July 2006. A daily forecast of the air quality (ozone and PM) over Europe is computed routinely. Since September 2008, the daily forecast ozone and PM air quality will be used in the Integrated Air Quality Platform for Europe under the Promote project.

References: Mallet and Sportisse (ACL-12, ACL-13), Mallet (TH-5)

## Model Performance Evaluation at Regional and Continental Scales

The PolypheMUS system hosts the 3D Chemistry Transport Model Polair3D with SIREAM for PM simulations. This model has been evaluated with data over Europe, Asia (as part of the MICS project), the Paris region, the Marseille region in the context of the ESCOMPTE field campaign and over Lille. Polair3D with MAM for PM simulations has been evaluated with data over Tokyo. An illustration of the results of those model evaluations at the regional scale is shown in Figure 11, which compares the PM concentrations at a station (Gennevilliers) in the Paris region.

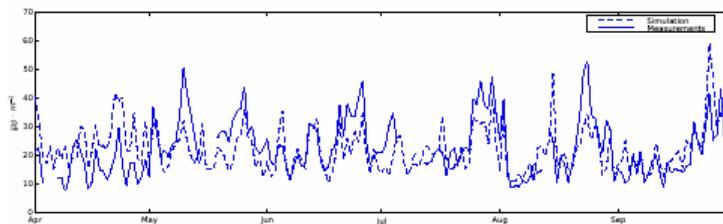


Figure 11. Time series of measured versus simulated PM concentrations at station Gennevilliers (Paris suburb) for April-October 2001.

Studies to assess the sensitivity of PM concentrations to different physical processes (such as coagulation, mass transfer by condensation/evaporation, sea-salt emissions, aqueous chemistry and heterogeneous reactions) were performed over Asia as part of the MICS project, Europe, Paris and Tokyo. For example, Figure 12 compares the results obtained at Kudan (Greater Tokyo) with Polair3D with different model configurations

(with heterogeneous reaction ( $\text{N}_2\text{O}_5$ ), without condensation, with a hybrid scheme for condensation/evaporation instead of assuming thermodynamic equilibrium) against data.

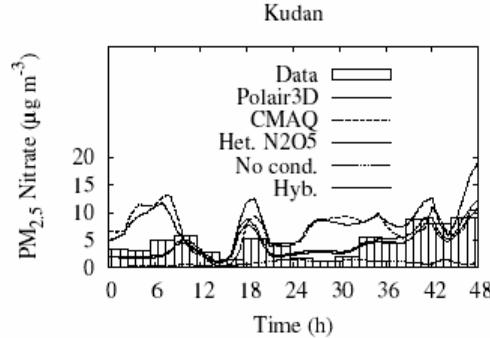


Figure 12. PM concentration of nitrate at Kudan (Greater Tokyo) for 9 and 10 December 1999. Different configurations of the aerosol model are investigated.

References: Tombette and Sportisse (ACL-35), Tombette (TH-11), Tombette et al. (AFF-16), Sartelet et al. (ACL-28, ACL-29, AP-130)

## Aerosol Optical Thickness

Specific radiative modules have been developed and coupled to the outputs of Polyphemus. The objective is for instance to compute the Aerosol Optical Thickness from outputs of the aerosol model SIREAM (Ph.D. thesis of Marilyne Tombette, 2007). Figure 13 shows the average simulated aerosol optical thickness (AOT) at 440 nm for 2005. High values are observed in North Africa due to Saharan dust. Comparisons have been made to Aeronet data. A sensitivity study shows there are large uncertainties in the computation of AOT.

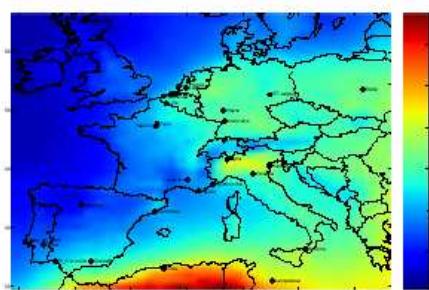


Figure 13. Average simulated AOT at 440nm over year 2005. Aeronet stations are drawn. Marilyne Tombette PhD Thesis.

References: Tombette et al. (ASCL-3), Tombette (TH-11)

## MICS Project

Thanks to a collaboration with CRIEPI (Central Research Institute of Electric Power Industry), CEREA participated to the phase 2 of MICS (Model InterComparison Study) Asia with Polair3D-SIREAM. Eight teams participated in the MICS Asia phase 2, 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. Figure 14 shows the concentration of sulfate over Asia for December 2001. A comprehensive sensitivity analysis was also performed. The variability of sulfate and nitrate concentrations induced by using different CTMs is compared to the variability induced by comparing different parameterizations in the aerosol module (Karine Kata-Sartelet).

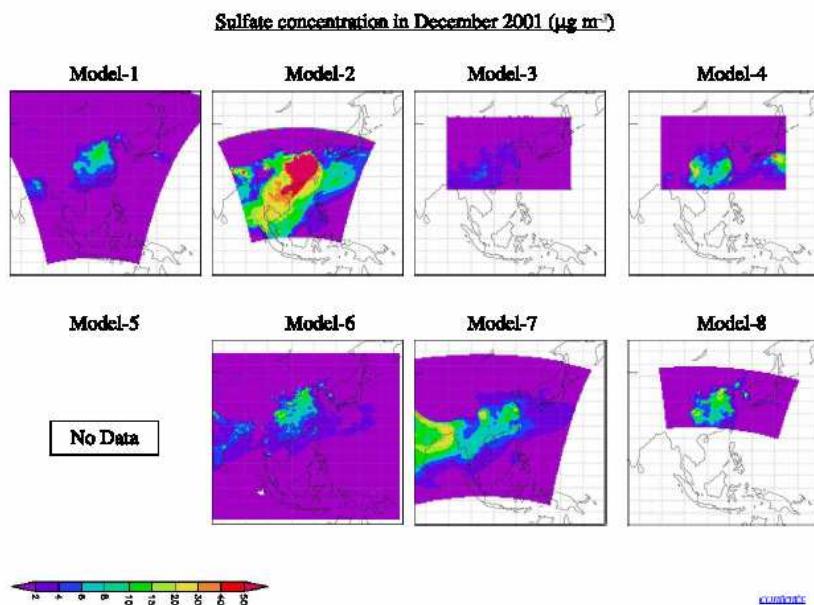


Figure 14. MICS Results: concentration of sulfate over Asia for December 2001 for the set of available models. Polair3D corresponds to Model 8.

References: Sartelet et al. (ACL-30), Carmichael et al. (ACL-43)

## Radiative Effects and Photolysis

Radiative effects are strongly controlled by the vertical distribution of aerosol composition and optical properties. In a work in progress (Elsa Real), the radiative effect of clouds on photolysis rates is taken into account by coupling the radiative transfer scheme FAST-J to the CTM Polair3D of Polyphemus. Currently, clear-sky photolysis rates are preprocessed data, which are tabulated using climatological values of temperature, pressure and ozone. They are thereafter corrected to take into account

clouds. The FASTJ scheme can now be used directly to preprocess photolysis rates taking into account the meteorology (temperature and pressure) and clouds. After the coupling of FASTJ to Polair3D, the modeled aerosol extinction and scattering profiles will also affect the photolysis rates to provide more accurate simulations of air quality by taking into account the effect of PM on atmospheric radiation.

## **Mercury and Heavy Metals**

The Ph.D. thesis of Yelva Roustan (2005) addressed the modeling of three heavy metals (mercury, lead and cadmium) over Europe. Processes for atmospheric mercury were incorporated in the Polair3D model. Model-to-data comparisons were performed for 2001 over Europe. Moreover, an innovative sensitivity analysis was developed and inverse modeling with respect to boundary conditions was performed. The potential effect of Arctic mercury depletion events was identified. For lead and cadmium, two advanced approaches were 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 consists in adding lead and cadmium as “inert” heavy metals in the size-resolved aerosol model SIREAM. An intercomparison and model-to-data comparisons were performed.

References: Roustan and Bocquet (ACL-14, ACL-15), Roustan et al. (ACLN-1), Roustan (TH-6)

## **Impact Studies at Continental Scale**

A task assessed the sensitivity of ozone concentrations with respect to emissions (Vivien Mallet and Bruno Sportisse). The sensitivity study dealt with the temporal, spatial and chemical features of NO<sub>x</sub> and COV emissions.

Cerea is also implied in the European projects NEEDS, HEIMTSA and EXIOPOL, devoted to Health Impact Assessment and Cost-Benefit Analysis. The objective is to apply the models provided through Polyphemus, especially the eulerian model Polair3D, within the EcoSense integrated assessment system (Yelva Roustan). These projects should enhance joint tasks with IER Stuttgart.

Moreover, Polyphemus is used by EDF Polska and by the consortium of associated Polish Universities (especially AGH University of Science and Technology, Krakow). The objective is to assess air quality in Polska and the related transboundary fluxes with a focus on Krakow.

Under the CAFE process (Clean Air For Europe/National Emission Ceiling), the impact for the year 2005 of the emissions from the French thermal power plants was computed for the Fossil-Fuel Fired Generation and Engineering Department of EDF. A specific project that addresses the potential impacts of thermal power plants in the Paris region is underway.

A new project started in 2008 on the impact of biofuels over Europe. 10% of the energy used for road transport was replaced by ethanol and biodiesel (Jérôme Favier, Karine Sartelet, Yelva Roustan). The impact on photochemistry and particles was assessed for the year 2005.

## **Atmospheric Dispersion of Radioactive Species**

An important application of Polyphemus is the forecast of the atmospheric dispersion of radioactive species. This work is conducted as a joint project with the Emergency Center of the French nuclear safety agency (IRSN). Extensive work (Ph.D. thesis of Denis Quélo) was devoted in 2005 and 2006 to the simulation of the Chernobyl accident. A sensitivity analysis was performed with respect to the parameterizations (including MM5 meteorological parameterizations) in order to investigate the sensitivity of wet and dry scavenging (key processes governing the atmospheric lifetime of radioactive species). Another sensitivity study based on adjoint modeling led to a quantitative description of any measurement sensitivity to dry deposition and wet scavenging parameterization schemes for the Chernobyl accident. Polyphemus is now used in the new operational forecast system at IRSN for regional scales.

References: Sportisse (ACL-32), Quélo et al. (ACL-27), Krysta (TH-7)

## **Multi-Media Modeling**

Impact of air quality pollutants on human health is a new field of application of the Polyphemus system, with a focus on thermal power plant impact. In the Ph.D. thesis of Solen Quéguiner (2008), the outputs of Polyphemus for lead and cadmium (air concentration and ground deposition) were coupled to the soil/watershed fate and transprt model OURSON developed at EDF R&D. OURSON describes pollution in the ecosystem, including soil, surface and groundwater, and the foodchain, to estimate doses for human beings. A model devoted to Persistent Organic Pollutants (POPs) is under development and evaluation within Polyphemus.

References: Queguiner et al. (ACL-53), Queguiner (TH-12)

## **Plume-In-Grid Modeling**

Polyphemus hosts two Gaussian models (a steady-state plume model and a puff model), that are currently developed and used for atmospheric dispersion at the local scale. Some statistics for the Prairie Grass Experiment are given in Table 2; they demonstrate that the Polyphemus models are comparable to existing standard atmospheric dispersion models used in North America and Europe in terms of performance. A major limitation of regional and continental scale air quality models is their inability to treat the local impacts of the plumes emitted from large point sources such as power plants and incinerators. To better represent those sources, it is possible to combine puff models with the grid-based air quality model in order to develop a subgrid-scale representation of the plume processes near the point of emission. Such a Plume-In-Grid capability is currently

being developed in Polyphemus for both inert and reactive species (Ph.D; thesis of Irène Korsakissok).

Table 2. Performance statistics for several steady-state Gaussian models: comparison of maximum arc concentration for simulation and observation - 43 trials from the Prairie Grass Experiment. ADMS, AERMOD and ISCST3 are standard regulatory models used in Europe and North America; Polyphemus was applied with three different options for parameterizing atmospheric dispersion (Briggs, Doury and a first-order closure scheme).

Model	Fractional Bias	Normalized Mean Square Error	Correlation coefficient	Fraction of simulations within a factor of 2 of the observations
ADMS	0.56	3.62	0.64	0.46
AERMOD	0.00	1.87	0.75	0.76
ISCST3	0.06	1.76	0.72	0.62
Polyphemus - Briggs	0.0	1.83	0.78	0.74
Polyphemus - Doury	0.46	4.47	0.42	0.27
Polyphemus - Similarity theory	-0.08	1.25	0.82	0.61

Reference: Korsakissok (AP-174)

## 1.4 Data Assimilation

This research area is covered by an INRIA/ENPC project-team hosted by CEREA, CLIME; it is devoted to data assimilation, image assimilation, inverse modeling, ensemble methods, network design and modeling systems for environmental applications. Note that the research activity of INRIA members of the CLIME project is consolidated in the CEREA activity report since 2007, though the CLIME project-team was created in 2005. In particular, through this consolidation, image assimilation activity is now part of the CEREA activity report.

### Inverse Modeling of Tracer Source

The dispersion of a passive tracer is described by a linear advection-diffusion equation. The objective is then to retrieve the emissions on the basis of observational data and of a

numerical model for the dispersion. Thanks to the linear nature of the underlying equations, this can be performed with adjoint solutions called retroplumes.

If the source is a point-wise source, the simplex method can be used (Jean-Pierre Issartel and Jérôme Baverel). The problem is more intricate for diffuse emissions. A geometric interpretation of the retroplumes was proposed by Jean-Pierre Issartel and applied to the retrieval of arsenic emissions in Chile (joint project with Laura Gallardo Klenner, CMM Chile).

Moreover, new approaches have been proposed for inverse modeling of passive tracers, using the maximum entropy on the mean principle (MEM, Marc Bocquet). The main advantage of this set of methods is the way the a priori knowledge is taken into account. In particular the positivity of the source can be numerically enforced, rigorously and efficiently. New cost functions, one for each prior, are generated by the MEM principle and can be especially devised for several types of application. They can be generated both in the state space or in the dual space of observations. The generated cost function is 4D-Var (4D-Var PSAS in the dual space), when the hypotheses on the source and the errors are Gaussian. In this latter case, it was shown to be equivalent to a projection onto the basis of retroplumes. These methods can be applied to accidental releases (for instance to the ETEX campaign), where they have been demonstrated to be very efficient. Besides, the optimization of the cost function can be performed both in the state space and in the space of observations (dual approach). When the number of observations is low compared to the number of unknown variables, the dual approach proves numerically fast. The method was tested on ETEX-I and ETEX-II. As for ETEX-I, the total mass is recovered and the correct grid-cell of the release is found, with about 65 % of the total mass in this grid cell (Figure 15).

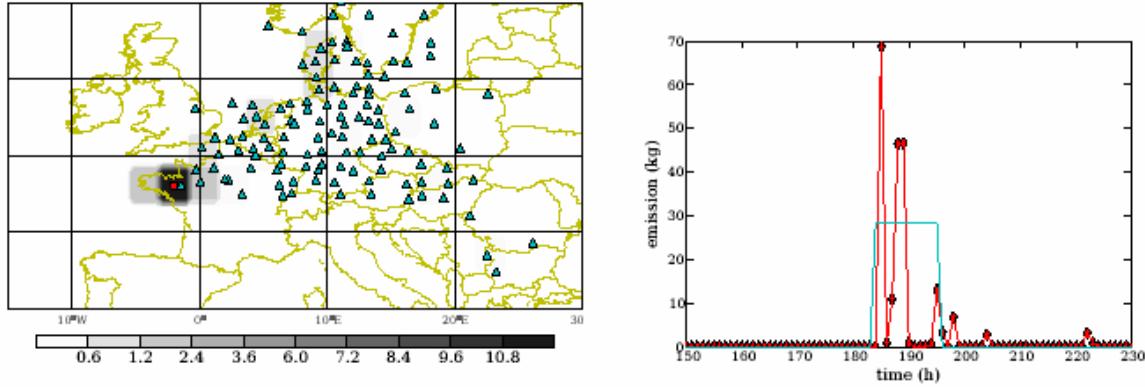


Figure 15. Left: a two-dimensional representation of the reconstructed source of ETEX-I, integrated in time. The inversion is based on the MEM principle. The reconstruction is based on all available positive measurements: the triangles mark the stations whose data were used in this inversion. Right: temporal profile of the solution in the true release grid-cell. 342 kg are recovered (222 kg in the correct grid-cell) against 340 kg known to have been released.

Another task is devoted to the assessment of the influence of grid resolution in the case of inverse problems with or without entropy regularization. The singular points in the retrieved sources around the monitoring stations are then explained. The existence of an optimal resolution has been proved and an indicator of the inverse modeling procedure has been proposed (Marc Bocquet).

References: Bocquet (ACL-2, ACL-3, ACL-4, ACL-47), Issartel (ACL-5), Krysta et al. (ACL-52)

## Advanced Data Assimilation for Air Pollutants

A natural follow-up to previous work was to use the best estimation of an accidental source of pollutant to forecast the pollutant plume, using this advanced non-Gaussian formalism. This was explained and demonstrated on ETEX-I (Marc Bocquet). Besides, one can adapt this technique to emergency situations where data come as the crisis unfolds, and where the best forecast is needed throughout the crisis. It was shown that in the context of ETEX-I, 15 hours were necessary to identify the source term, for a satisfying forecast of the plume to be given (Figure 16).

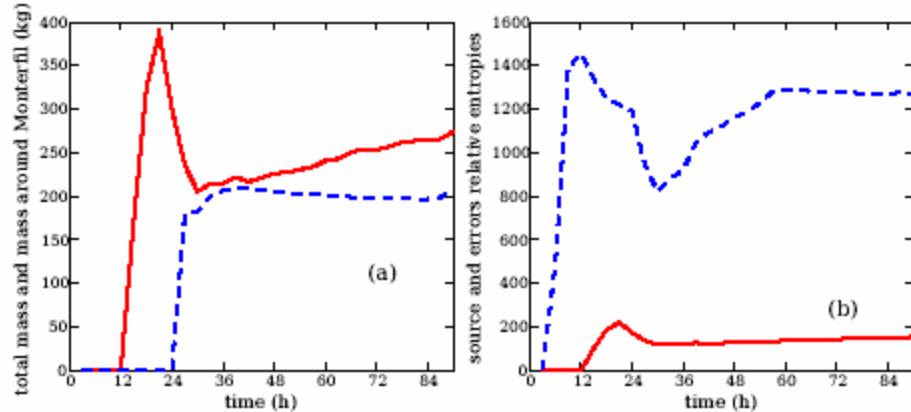


Figure 16. Total PMCH (340 kg were released in ETEX-I in Monterfil) reconstructed mass (full line) and reconstructed mass around Monterfil (dashed line) against time (a). Relative entropy for the source (full line) and relative entropy for the errors (dashed line) against time (b). The time origin corresponds to 23 October 1994 15:00 UTC, one hour before the start of the release.

Reference: Bocquet (ACL-16)

## Short-Range Inverse Modeling

Since 2003, CEREA has participated in a joint project with IRSN devoted to Inverse Modeling of an Accidental Release in the atmosphere (MIRA). The natural scale of this project is at most a few kilometers around a nuclear power plant. A preliminary task was accomplished in 2004-2005 with twin experiments (Denis Quélo and Bruno Sportisse). Some experiments were carried out in order to invert parameters related to the emission

of a point source or physical parameters for turbulent dispersion (Ph.D. thesis of Monika Krysta). A variational approach was applied to a puff model with a set of data obtained in the wind tunnel of “École Centrale de Lyon” (with a small scale model of the Bugey power plant). The evaluation of the monitoring network was also completed with cross validation techniques.

References: Krysta et al. (ACL-11), Quélo et al. (ACL-8), Quélo (TH-2), Krysta (TH-7)

## Inverse Modeling of Radionuclides Accidental Release over Europe

First experiments in inverse modeling of radionuclides at regional scale have been investigated using both synthetic and real data. This is a test application for the Maximum Entropy on the Mean [MEM] techniques, with a physics involving removal processes. New objective functions specifically designed for localization of sources were analytically derived and tested numerically on two hypothetical accidents in Europe. The sensitivity of the inversion with respect to the monitoring network spatial distribution, the meteorological conditions, the number of observations, was studied. The methods were then applied to the Algeciras radioactivity release incident (Monika Krysta and Marc Bocquet). The temporal inversion leads to satisfactory results while a reasonable 3D reconstruction is proven to be impossible with the available data (Figure 17).

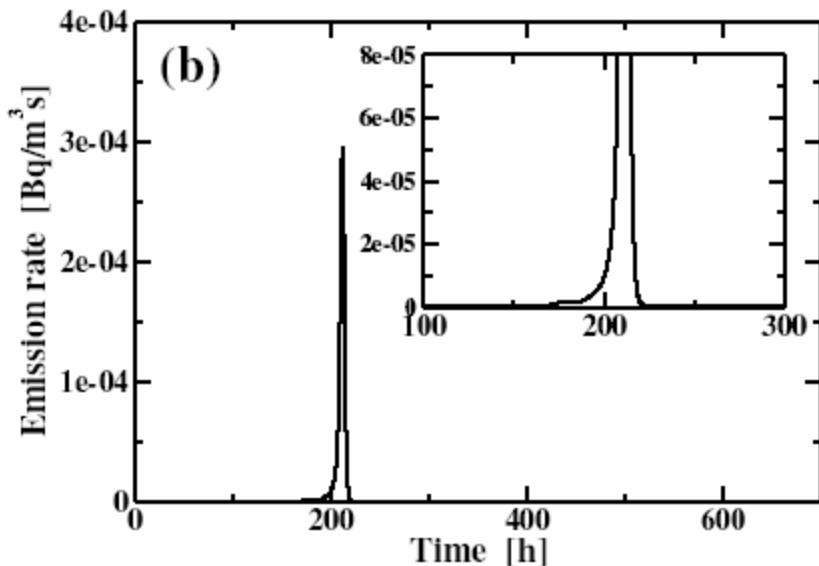


Figure 17. Reconstructed profile of an accidental release of Cs-137 in Algeciras, Spain, using especially devised cost-function. Some  $[2.96 \cdot 10^{11}, 2.96 \cdot 10^{12}]$  Bq have been released between 01:00 and 03:00 UTC on 30 May 1998. The time of the release corresponds to 215-217 on the horizontal axis. Reconstructed activity:  $2.96 \cdot 10^{12}$  Bq.

The MEM method was also applied to the Chernobyl accident (Xavier Davoine and Marc Bocquet). The location was supposed to be known, and a two-dimensional (temporal and vertical) profile is sought for. The isotopes available for long-range transport were investigated: I131, Cs137, and Cs134. It appeared that the inversions were very sensitive

to the mass scale that entered the definition of the prior which enforces the positivity of the source, in addition to the usual ratio of covariances between background and errors. The L-curve semi-empirical approach has been used to estimate the value of these parameters. The total activity reconstructed for the three species has been shown to be only within 10% to 30% of the previous official estimations (Figure 18).

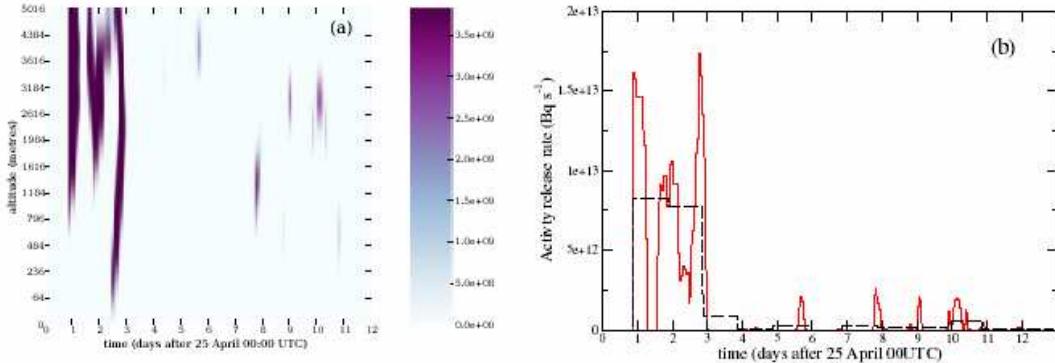


Figure 18. A typical solution of the Chernobyl source inversion problem based on a Bernoulli source prior, and a uniform Gaussian error prior. The left-hand-side figure (a) is a density graph representing the activity released per unit of time and unit of altitude (in  $\text{Bq m s}$ ). The right-hand-side figure (b) shows reconstructed hourly and day-to-day (dashed line) profiles of the iodine-131 release rate.

References: Krysta and Bocquet (ACL-22), Davoine and Bocquet (ACL-18), Krysta (TH-7)

## Inverse Modeling of Ozone Precursors Using Variational Assimilation

The use of 4D-Var techniques requires the development of the adjoint model of Polair3D (Denis Quélo). An application was the inverse modeling of  $\text{NO}_x$  emissions at regional scale.

The emissions fluxes represent one of the main uncertainties in Chemistry-Transport Models. These uncertainties are mainly related to the time distribution. A task was completed over the Lille region (May 1998) on the basis of observational data for ozone and  $\text{NO}_x$ . The control parameters are hourly coefficients applied to emissions of  $\text{NO}_x$  (Figure 19). The forecast of ozone and  $\text{NO}_x$  with the improved emission fluxes is significantly improved for the learning week and for the next two weeks after the learning period (Denis Quélo, Vivien Mallet and Bruno Sportisse).

References: Quélo et al. (ACL-7), Quélo (TH-2)

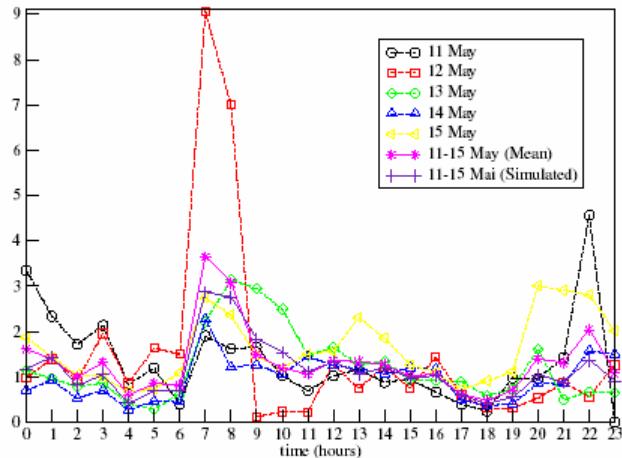


Figure 19. Optimized time distributions of NO emissions over different periods (Lille run).

## Sensitivity Analysis and Inverse Modeling of Mercury over Europe

Elemental mercury is a long-lived species (with a timescale of one year). It is, therefore, relevant to perform a sensitivity analysis with respect to lateral boundary conditions for a simulation at continental scale. Adjoint methods were used in order to quantify the sensitivity of observational data of mercury over Europe with respect to emissions, initial conditions and boundary conditions (Yelva Roustan , Ph.D.. thesis) (Figure 20, see also Section 1.3 ).

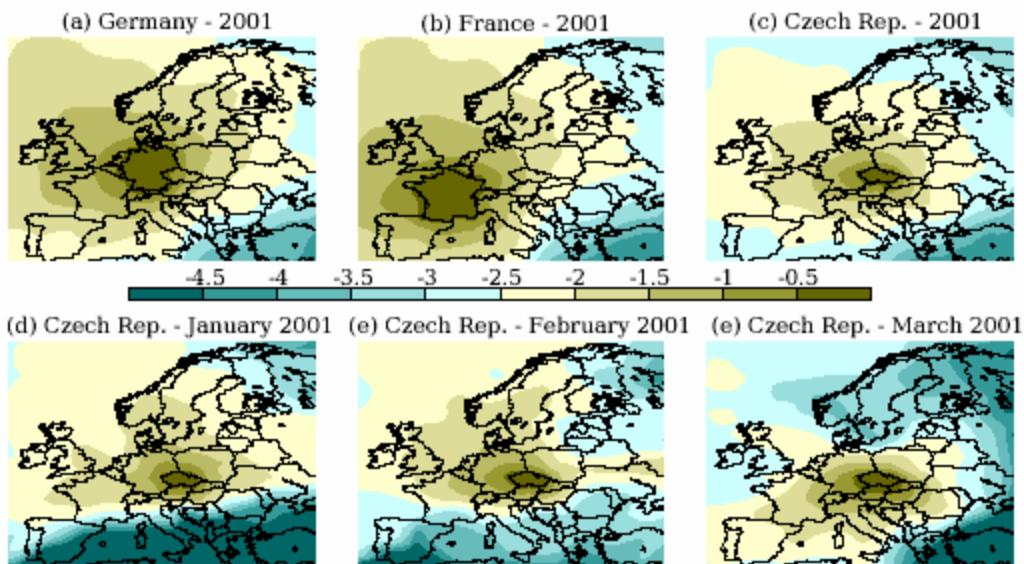


Figure 20. Sensitivity to emissions of the mercury annual average modeled air concentration measurement. Application to transboundaries pollution issues for Germany (a), France (b) and the Czech Republic (c). In the case of the Czech Republic examples of monthly averaged sensitivities are also given to demonstrate the intra-year variability of the sensitivity ((d), (e) and (f)).

These tools were also used to invert some of the boundary conditions, in particular the northern border, sensitive to the mercury depletion event. Also it is shown that with the present EMEP network, not enough data are available to invert emissions parameters (Figure 21).

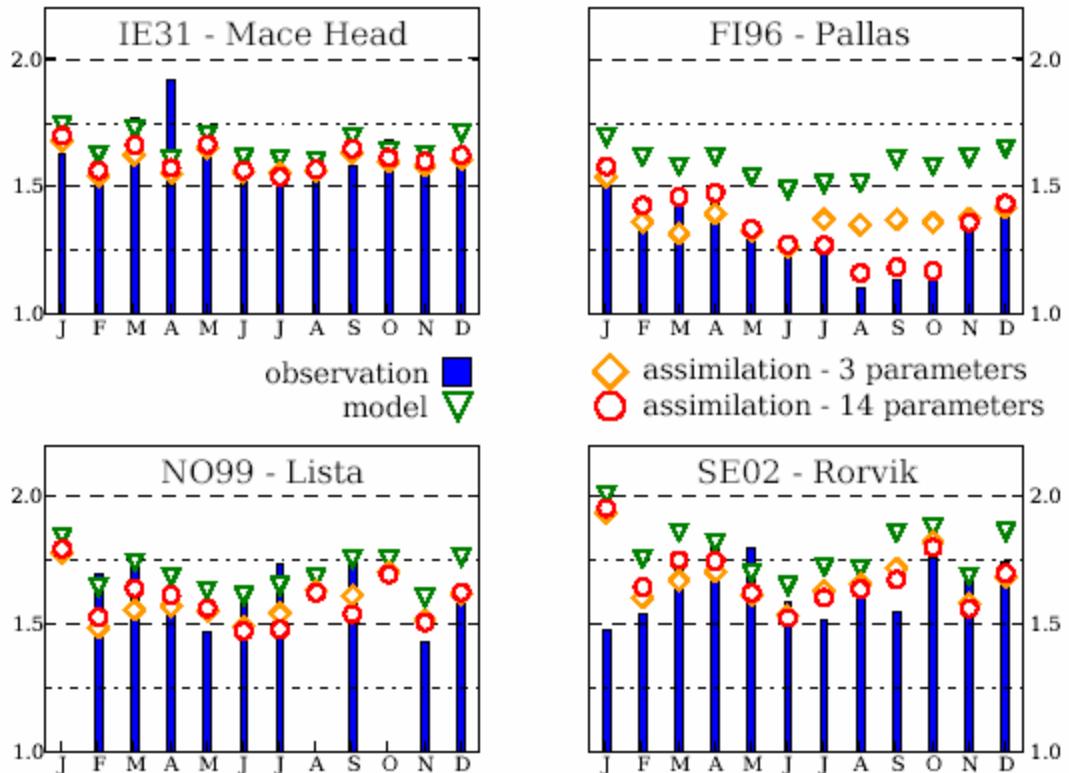


Figure 21. Monthly averaged ground measurement of gaseous mercury (in ng m⁻³) at four EMEP sites for the year 2001. The observation data of the first two stations are used for the assimilation process.

References: Roustan and Bocquet (ACL-14, ACL-15), Roustan (TH-6)

## Comparison of Sequential and Variational Methods in Air Quality

German Torrès achieved his postdoctoral fellowship devoted to air quality forecast over Berlin (in collaboration with GMD First, Berlin). A Reduced Rank Square Root Filter and an Ensemble Kalman Filter were developed and some preliminary applications to an academic case were performed.

Both variational (4D-Var) and sequential (EnKF) data assimilation techniques have been implemented in the Polyphemus system using the CTM Polair3D, and the merits of both

approaches have been compared (Lin Wu, Vivien Mallet, Marc Bocquet and Bruno Sportisse). A secondary aim is to study the impact of non-linearities in air quality data assimilation (main topic of ADOQA, a Research Action of INRIA). The drivers for 4D-Var and several variants of the Kalman filter are now implemented in Polyphemus, and they are being extensively tested (Figure 22).

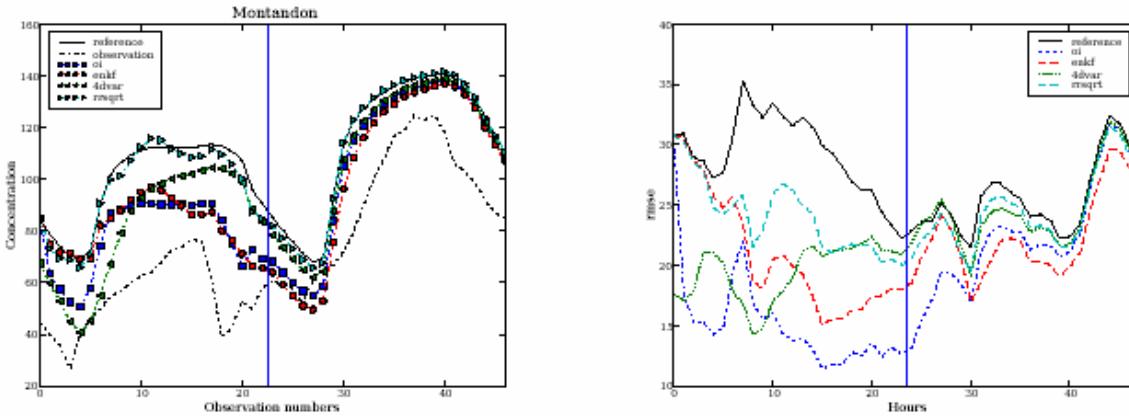


Figure 22. Left: time evolution of ozone concentrations against available observations at EMEP station Montandon, for the reference simulation (without assimilation), the simulation with assimilation (OI, EnKF, RRSQRT and 4D-Var). The assimilation is Right: time evolution of root mean square error of ozone concentrations compared with all available observations. The total RMSE over two days is 27.5 for reference, 18.9 for OI, 21.7 for EnKF, 22.1 for 4D-Var, and 24.4 for RRSQRT.

Reference: Wu et al. (ACL-50)

## Ensemble Methods for Air Quality Forecast

Air quality forecasts are characterized by high uncertainties which come primarily from the physical formulation of the models (parameterizations) and from the input data (e.g., emissions, boundary conditions). Large ensemble simulations were built in order to account for these uncertainties. This provided a coarse estimate of the uncertainties in the predictions, and this allowed significant improvements in the forecasts.

For the latter, weights (depending on past observations and on past model outputs) were associated to the models in the ensemble in order to form a linear combination of the models forecasts. The methods, so-called sequential aggregation methods, essentially derive from machine learning algorithms. They come with strong theoretical guarantees on their performance as they are guaranteed to be competitive against the best constant linear combination of models; they also proved to be successful and robust in practice,

and they are in the way to be applied for operational forecasts (on the Prév'air platform, by INERIS).

In order to enhance the ensemble abilities, a major research objective is the calibration of the ensemble, that is, the selection of the models to be included in the ensemble. First results were obtained with the question reformulated as a combinatorial optimization problem where the target criteria (e.g., a Brier score) is minimized over a discrete set of models (i.e., a large ensemble).

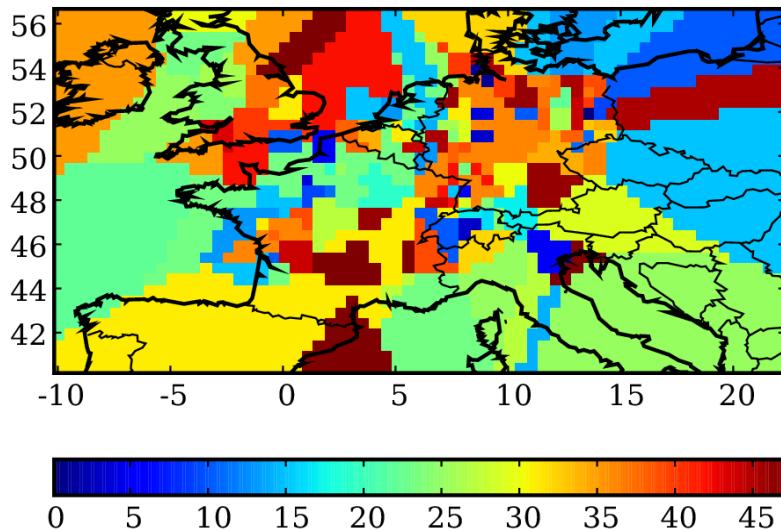


Figure 23. Map of best model indices. In each cell of the discretized domain, the color shows which model (marked with its index, in  $[0, 47]$ , so for a 48-member ensemble) gives the best ozone peak forecast on 7 May 2001 at the closest station to the cell center. This shows that many models can deliver the best forecast at some point.

References: Mallet and Sportisse (ACL-12, ACL-13), Mallet et al. (ACL-54), Mallet (TH-5)

## Network Design for Atmospheric Dispersion

A research project in network design for air quality started in January 2006 with the Ph.D. thesis of Rachid Abida (ENPC/IRSN support). IRSN asked CEREIA to help define its future aerosol station network for the evaluation of a hypothetical accidental radioactive release in France (Descartes project). The results of the preliminary work were given in a first report (Nikki Vercauteren and Marc Bocquet). A basis of 15000 radiological accident simulations were computed using Polair3D, for two types of accident, and one species (among three possible). An objective function was then defined to evaluate any monitoring network. The capability of a network to extrapolate activity measurements on the ungauged grid cells of the domain is the primary objective. The cost

function is therefore a measure of the discrepancies between the extrapolation and the true values as read in the simulation database, for all accidents of the database. Several methods of extrapolation were considered: closest-point approximation, ordinary kriging, splines. A simulated annealing optimization was then performed, for a fixed number of stations, to reach a close to optimal network. The first phase of the work consisted in implementing this program using one month of simulations from the database, and developing the parallel algorithm (Lam MPI and POSIX threads) on the CEREA PCs. In the second phase (Rachid Abida and Marc Bocquet), the study was extended to one year of simulation. The sensitivity of the network performance to the number of stations was tested. One of the key result is the very high sensitivity of the design to the definition of the cost function, and in particular to the norm that pounds the discrepancies. It was shown that, because of the sharp gradients in an accidental dispersion, the usual least-square criterion arranges all stations around the source, neglecting the evaluation of the subsequent plume far way from the source (Figure 24). A milder norm was therefore advocated (or norm).

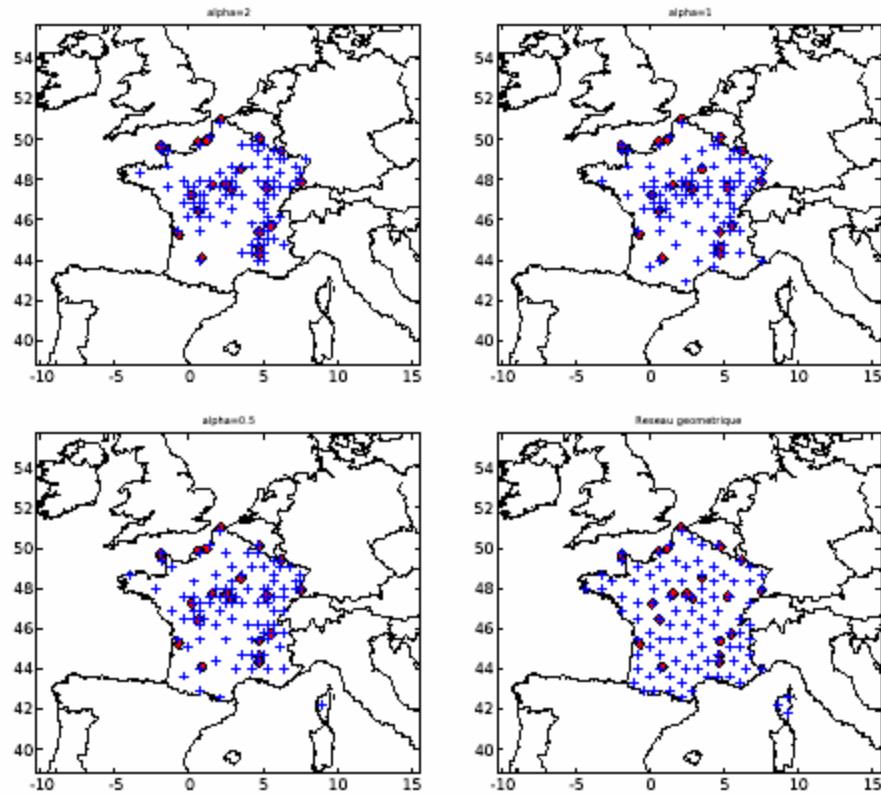


Figure 24. Monitoring networks (100 stations) optimized for the best extrapolation of radionuclides concentration fields over the French territory, on a yearly database of 7000 fictitious accidents. The red rhombuses represent the sources (civil nuclear sites), and the blue crosses represent the network stations. Each of the networks is optimized on the basis of a different cost function built on a certain power ( $\alpha$ ) of each of the departure terms. The last network results from a geometric optimization: no simulation is used.

A similar project is also carried out in a joint project with DGA (Irène Korsakissok, Vivien Mallet and Bruno Sportisse). The aim is to design and evaluate networks for defense applications at regional and local scale (on the battlefield). A tool was designed to evaluate network performance in terms of detection probability and saturation time. It was tested on networks designed by taking the sensors that have the best detection probability or the best saturation time. A sensitivity study was also achieved for parameters such as wind speed and angle variation, the species type (biological, radioactive or chemical) and diameter to be detected, and the number of sensors in the network (Figure 25).

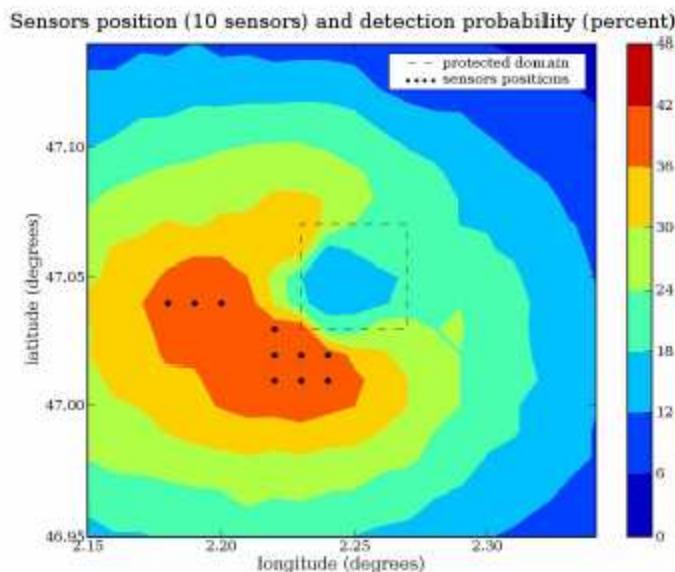


Figure 25. Network design on a battlefield (regional scale). Map of detection probability at regional scale for all possible sensors, as well as the sensors positions for the ten sensors having the best detection probability.

Reference: Abida et al. (ACL-46)

## Reduced Models and Propagation of Uncertainties

The use of data assimilation methods for large-dimensional systems such as those involved in chemistry-transport models may require the search for reduced models. Many approaches have been developed and benchmarked: among them, one can cite a singular perturbation technique based on multiscale reduction, reduced Monte-Carlo techniques (DEMM), expansion in chaos polynomial, High Dimensional Model Representation (HDMR) or Proper Orthogonal Decomposition (Rafik Djouad, Jaouad Boutahar and Bruno Sportisse).

Reference: Sportisse and Djouad (ACL-33)

## Image Processing versus Data Assimilation

We proposed to use the data assimilation framework to study a class of ill-posed *image processing* problems: the equations used to model the image properties are under-determined and the solution is usually obtained using regularization techniques. Data assimilation solves a system of three components with respect to the state vector, which represents the solution of the problem (for example a vector field for motion studies on sequences of images):

1. The first one is called "evolution equation". It describes the evolution of the state vector in the time domain. This evolution equation should include the available physical knowledge on the image acquisition and the studied phenomena.
2. The second one, called "observation equation", describes the mathematical link between the state vector (the result we are looking for) and the observations included in the sequence of images.
3. And the third one describes the initial condition, which can be obtained by any classical image processing method.

Research studies are carried out to understand:

- Which physics to include in the evolution equation?
- What is visualised on the images and should be linked to the state vector?
- How to use the covariance matrices, describing the errors of each term of the system, for solving the problems of missing data, of acquisition noise, ... ?

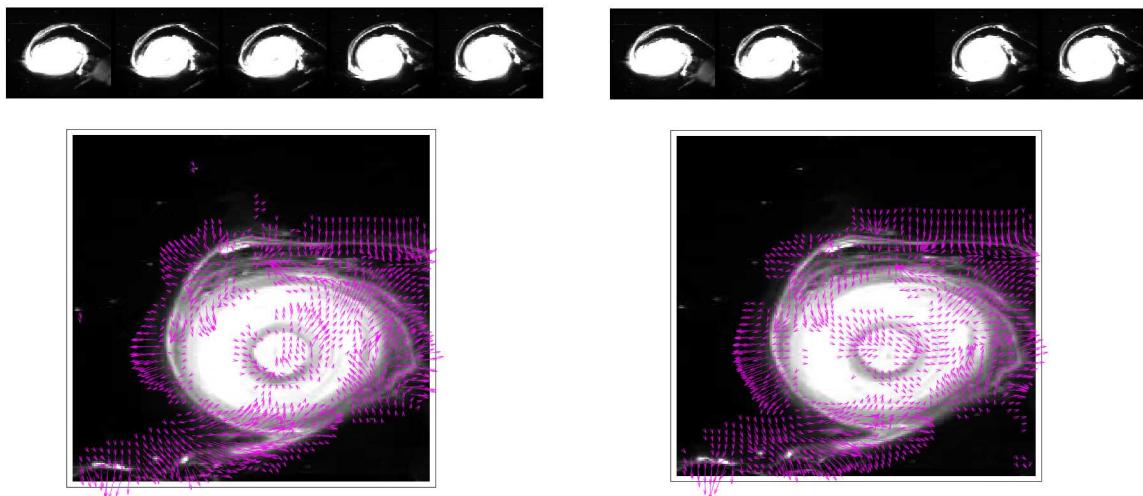


Figure 26. Sequence of vortice images obtained from the Coriolis platform (LEGI in Grenoble). On the left, the image is treated using regularization (radiometric conservation law and smoothness of motion). On the right, the image is assimilated into a transport model, so that missing (or corrupted) data can be compensated by knowledge of physical laws implemented in the model (here: one missing shot).

Reference: Grazzini et al. (ACL-36)

## Image Assimilation for Environmental Forecast

We introduced a methodology for using structured information, contained in images, for improving environmental forecasting. It is based on two steps:

1. Images are first processed in order to estimate relevant image information;
2. This image information is then considered as *pseudo-observations* assimilated in a simulation model in order to compute the forecast.

The pseudo-observations can be estimated using either image processing approaches or the data assimilation framework. The latter needs the definition of an *Image Model*: images are assimilated into this model to estimate pseudo-observations. The use of data assimilation methods helps to manage the missing data in an optimal way. The Image Model is designed in order to be consistent with the physical knowledge of the observed phenomena and to be representative of the visible information that has potential to constrain the environmental simulation model.

This two-steps approach, relying on data assimilation techniques, gives the opportunity to couple the Image Model and the environmental simulation model in order to enhance forecast results. The method has been applied in the context of ocean circulation: Sea Surface Temperature images are used to estimate the surface velocity, in turn assimilated in an operational Black Sea circulation model.

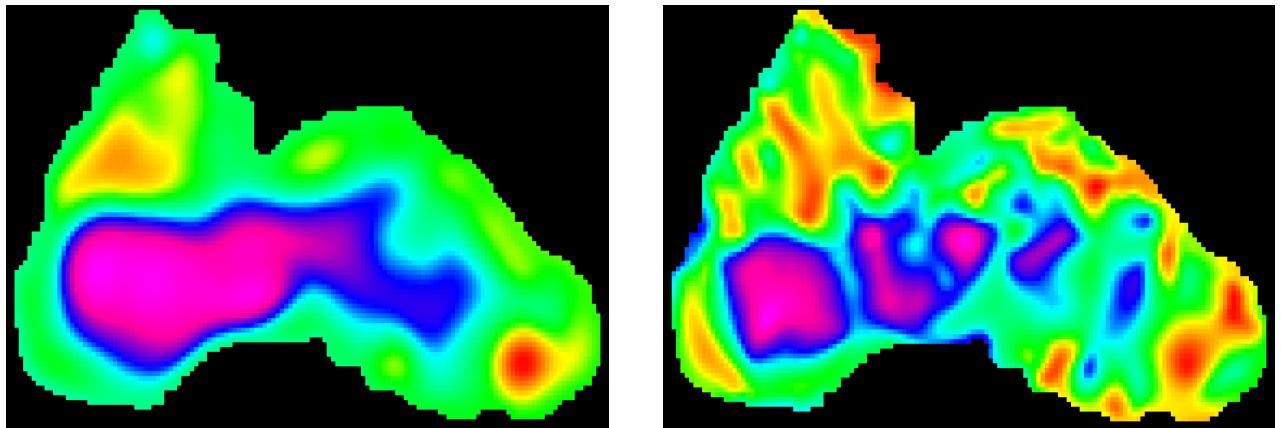


Figure 27. Assimilation of pseudo-wind fields from images of the Black Sea. Left: without assimilation. Right: with assimilation.

## 1.5 Meteorological Measurements

This research area has been at EDF-R&D for many years and was integrated in CEREIA at the beginning of 2005. The projects are related to the needs of EDF for atmospheric dispersion at an industrial or urban site, and for wind energy resource assessment, in close link with the Mercure\_Saturne team (see Section 1.2). The field campaigns are

primarily devoted to the creation of data bases for numerical simulations, and to instrument testing, especially wind profilers (sodar, UHF radar, lidar). Four people are involved in this area. A key point of this research area is the partnership with the IPSL observational site (SIRTA) in the southern suburb of Paris at Palaiseau.

## Sodar Intercomparison

In 2005 CEREA performed a campaign of intercomparison for sodars, in collaboration with “Centre scientifique et technique du bâtiment” (CSTB). The goal was to evaluate the quality of measurements and the acoustic disturbance of several commercialized mini-sodars, to select an instrument for wind and turbulence measurements at both French nuclear power plant sites and wind energy production sites. The campaign site was very flat and without obstacles, therefore, well adapted for intercomparisons. During two months, four sodars were compared with a 80-meters mast instrumented with cup and sonic anemometers, and with a reference sodar which had been extensively evaluated in the past. The results showed significant differences of behaviour between the 4 tested sodars, especially for very windy or rainy situations, which generally correspond to unfavourable conditions for sodars. Two sodars exhibited very good statistical comparisons with sonic anemometers, without any calibration or data filtering. But only one was able to measure the strongest winds encountered during the campaign ( $18 \text{ m s}^{-1}$  at 80 meters agl), and to maintain very good data quality for these winds. A simple method using the sodar data was tested to calculate the annual mean wind speed at hub height, here 80 m above ground level (agl), whose accuracy determines the quality of the energy production assessment. With this method, the sodar data provided by the two-months campaign combined with one-year measurements of a cup anemometer (at 40 m agl) allow to decrease by a factor of 3 the relative error for the mean annual wind speed at hub height, when compared to a vertical extrapolation by a power law.

References: Musson-Genon et al. (ACL-26), Dupont et al. (AP-157, AP-158), Dupont and Flori (AFF-31)

## Tests of a UHF Radar and Derivation of Turbulent Parameters

A Degréane UHF radar was extensively tested during several years in collaboration with the “Centre de Recherches Atmosphériques” (“Laboratoire d’Aérologie”) at Lannemezan plateau. It is well known that ground clutter and problem of commutation between emission and reception prevent UHF radar from giving good quality measurements in the first two hundred meters of the atmosphere. During 2005, a campaign was initiated in order to test some important modifications performed by Degréane on the emitted pulse and on the receiver. The data of this campaign have shown that the availability rate of validated data at the first level of the radar (85 m) is now larger than 90%, and that the measurements of wind speed and direction at this level are in very good agreement with the measurements of the reference sodar Remtech PA2 and the ultrasonic anemometer (bias less than  $0.5 \text{ m s}^{-1}$  and  $5^\circ$  speed and direction, standard deviation about  $1 \text{ m s}^{-1}$  and  $30^\circ$ ). Moreover, the use of the spectral width of the UHF meteorological peak makes it possible to determine some turbulent parameters such as the dissipation rate of kinetic

energy. The comparison of the spectral width on the UHF vertical beam with the standard deviation of vertical velocity measured by a sonic anemometer shows a reasonable agreement during daytime, but large differences during night time. Figure 28 shows that, on the whole, the correlation is lower than the one between sodar and sonic measurements of standard deviation of vertical velocity. It is therefore necessary to improve the methodology to extract a reliable turbulence information from UHF radar data, especially in stable conditions.

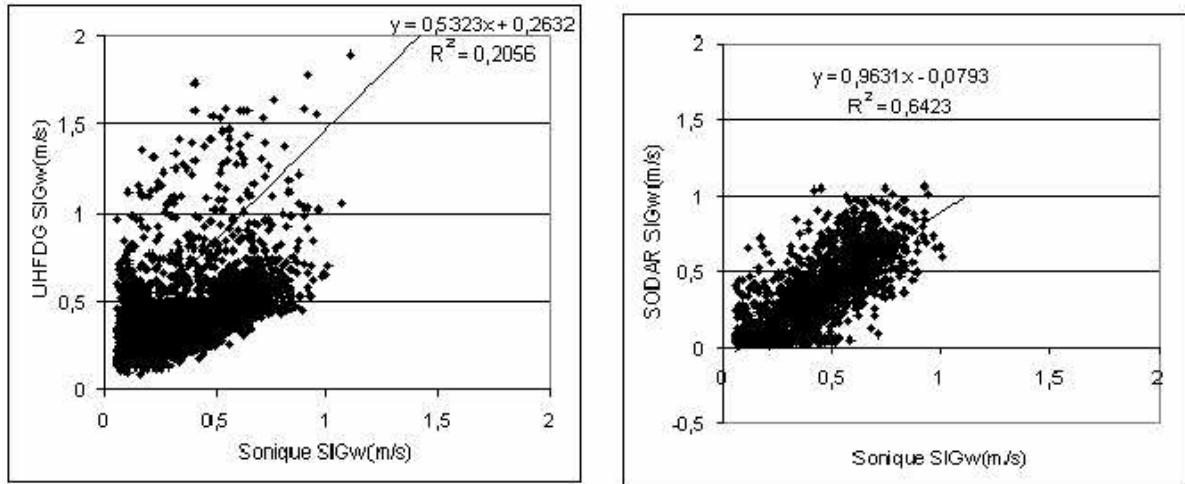


Figure 28. Comparison between spectral width measured on UHF vertical beam and standard deviation of vertical velocity measured by sonic anemometer (left panel) and between standard deviation of vertical velocity measured by sodar and sonic anemometer (right panel).

Reference: Dupont et al. (AP-132)

### **Collaboration with IPSL (Institut Pierre-Simon Laplace)**

In a collaboration with the IPSL Institute, an important set of meteorological instruments was installed during 2006 on the experimental site of IPSL (SIRTA, located about 25 km south-west of Paris, at Ecole Polytechnique in Palaiseau). SIRTA gathers a large set of remote sensing instruments (lidars and radars) and is involved in international networks of experimental sites devoted to research in aerosols and clouds. CEREA has primarily brought instruments for wind and turbulence measurements (UHF radar, sodar, sonic anemometers), but also radiation, temperature and humidity sensors (Figure 29). Four areas, with distances ranging from several hundreds of meters to one kilometer, have been or are about to be instrumented on the site in order to document the flow heterogeneities. This includes one area near a building. A joint project with IPSL has been retained by the Ile de France region (SESAME program) to strengthen the instrumental set up and thus to create with SIRTA a regional observatory for research in meteorology and air quality.

Measurements are performed on a routine mode in order to constitute a long-term (several years) data set. This data set permits an extended validation of the Mercure\_Saturne code including a wide range of meteorological situations. This comparison between measurements and simulations focuses on the ability of this code to simulate correctly the micro-scale meteorological heterogeneities induced by the complex land use of SIRTA (buildings, trees, water) and by the near valleys. The goal is to improve the operational abilities of the Mercure\_Saturne model, and thus to prepare a future use of this code for impact studies (for EDF power plants, roads traffic ...), and for wind energy resource assessment.



Figure 29. Views of the radar UHF (left) and the 30-meter mast (right) installed on the SIRTA site.

In 2007, a fine grid of the site has been prepared with a horizontal mesh ranging from 5 to 25 m. The first simulations show that Mercure\_Saturne reproduces correctly the modifications of the flow by the buildings (Figure 30). Simulations are now going to be performed for a large number of meteorological conditions in order to study changes in wind and turbulence fields as a function of several parameters such as wind direction and vertical stability.

CEREA instruments are also used in collaboration with other laboratories in field campaigns focusing on specific scientific objectives. CEREA is currently involved with IPSL and Météo-France in the Paris-Fog project, which is supported by the French

research atmospheric program LEFE. This project is dedicated to the observation and numerical simulation of turbulent, radiative, dynamical, and microphysical processes involved in the life cycle of fog. The field campaign took place at SIRTA between November 2006 and March 2007. Most of the instruments have worked continuously, but 15 IOPs (Intensive Observation Period), including additional measurements (radiosoundings, tethered balloon, aerosols and droplets measurements), have been documented. These IOPs correspond to different kinds of fog, in terms of physical processes, spatial heterogeneity, and time evolution. 1-D simulations have been performed with Mercure\_Saturne in order to validate the physical parameterizations (see Section 1.2), and 3-D simulations will follow, focusing primarily for radiative fog events of the campaign.

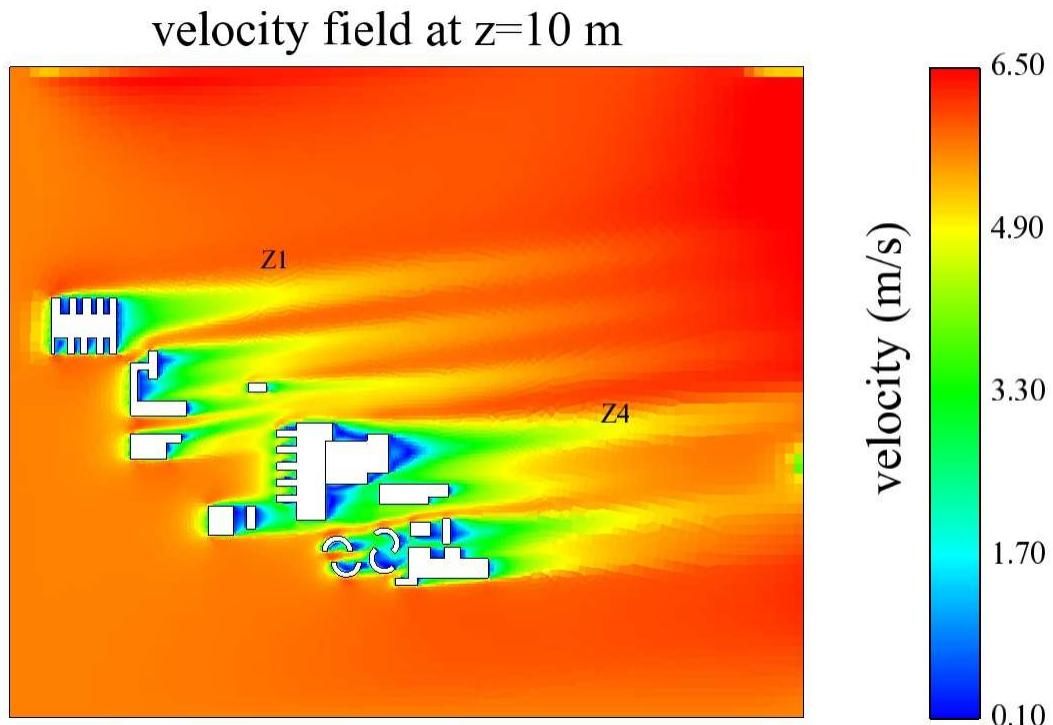


Figure 30. Wind speed at 10 m above ground level on SIRTA site for a south-west incoming wind.

Reference: Challet et al. (AFF-32)

### Campaign for Wind Energy Resource Assessment in Complex Terrain

Wind energy resource is generally estimated with linearized models of flow. However, the limitations of this kind of models in complex terrain are well known, and CFD codes are more and more considered as valuable tools for sites characterized by complex orography and/or forest. Moreover, the sodar campaign performed during winter 2005-2006 has shown that sodar measurements can contribute to improve the methodology to calculate the mean annual wind speed at hub height. A 1-year campaign of wind and turbulence measurements has been performed on a future wind energy production site

between June 2007 and June 2008. The selected site is located in southern France and is characterized both by strong slopes and forest. The main objective is to provide a well documented data set for the definition and the validation of a new methodology of wind resource estimates with the Mercure\_Saturne code (Ph.D. thesis of Laurent Laporte). The horizontal and vertical heterogeneities of wind and turbulence are documented by means of 2 sodars and 4 instrumented masts among which one 80 m high mast equipped with cup and sonic anemometers, vanes, and temperature sensors (Figure 31). The first analyses indicate that the wind vertical profile measured on the crest are quite well mixed and that the turbulent kinetic energy is often very high. The measurements have been used to correct the mesoscale information for the preparation of the lateral boundary conditions, and to compare the Mercure\_Saturne simulations on some selected situations (see part 2.1). The campaign also aims to evaluate the behavior of a mini-sodar in very difficult conditions (complex terrain, strong ground clutters and strong winds). This mini-sodar has provided measurements which are well correlated with the sonic anemometers, but with a tendency to underestimate wind speed (Figure 32).

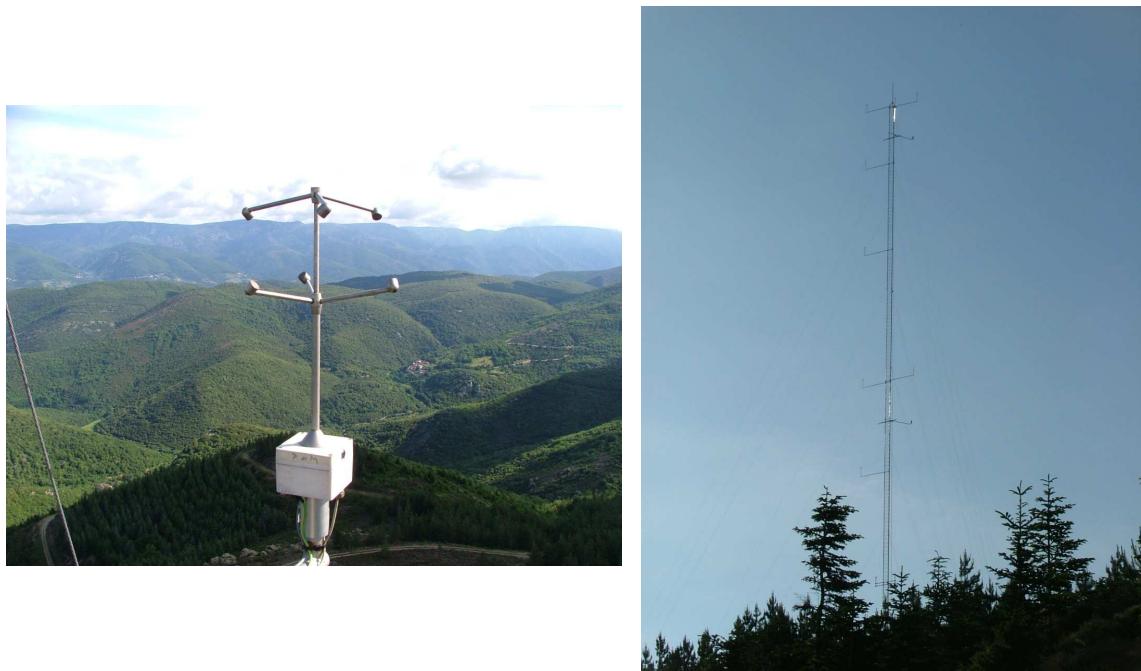


Figure 31. View of the 80 m high mast (right) and sonic anemometer (left).

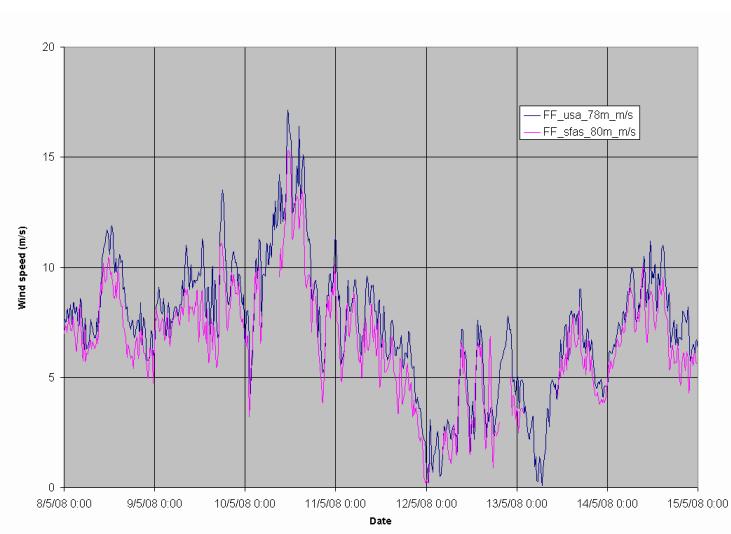


Figure 32. Wind speed measured by the sodar Scintec SFAS compared to a Metek USA-1 sonic anemometer, for the week 8 to 15 May 2008.

## **1.6 Self-Evaluation**

CEREA is a young laboratory since it was officially started in 2004. CEREA can be considered to be a success story in terms of its significant contributions to both research and teaching in just a few years. The large number of scientific publications in international peer-reviewed journals (about 50 over the past four years) demonstrates that the quality of the research is consistent with the international standards of the discipline. The number of Ph.D. granted by CEREA (12 over the past 4.5 years) is consistent with expectations for a new laboratory. Courses taught by CEREA staff correspond to the laboratory main expertise (i.e., air pollution and mathematical modeling) and have led to one major textbook and several course material documents. In addition, CEREA has produced several new methods that have significantly contributed to the advancement of the science and are now used operationally by various organizations (e.g., air quality forecasting techniques used at INERIS, monitoring network design methodologies used at IRSN, dispersion studies at various EDF sites conducted with CEREA models, a model used for air quality forecasting during the Beijing Olympics). Therefore, we believe that CEREA has met or exceeded all the major objectives that were defined four years ago at the moment of its inception.

There are, however, a few areas where improvements will help increase the international exposure of CEREA. First, one major challenge for CEREA is to coordinate activities among three groups located on three distinct sites (ENPC, EDF and INRIA). These three groups bring diverse types of expertise to CEREA, which contribute to the high quality of the research being conducted. However, although some individuals are quite active in fostering collaborations among the various sites, the geographical distances hinder communications among some parts of those groups and more action will be needed to ensure that all members of CEREA continue to actively participate in the laboratory activities and do not become isolated.

Second, more emphasis must be placed on establishing partnerships with research groups that are active in experimental work (both laboratory and field experiments). CEREA already has a group, which is active in meteorological measurements of the atmospheric boundary layer; however, there is no expertise at CEREA in measurements of the chemical composition of the atmosphere. Such partnerships will be key to future endeavors because scientific advances typically involve a combination of theoretical and experimental work; CEREA is a leader in the former but needs to team with other research groups to have access to the latter. If these two current weaknesses are addressed effectively, one can be confident that CEREA will continue to be a dynamic laboratory that contributes significantly to research and teaching in the atmospheric and environmental sciences.

## **2. Production scientifique**

Le chapitre 2.1 présente les publications du CEREA depuis 2004 et le chapitre 2.2 présente les publications depuis 2004 du nouveau directeur du CEREA qui a pris ses fonctions le 1<sup>er</sup> août 2008.

### **2.1 Publications du CEREA**

#### **2.1.1 Articles dans des revues avec comité de lecture répertoriées dans les bases de données internationales (ACL)**

##### **2004**

1. Boutahar, J., Lacour, S., Mallet, V., Quélo, D., Roustan, Y., Sportisse, B. (2004). Development and validation of a fully modular platform for numerical modelling of air pollution: Polair3D. *Int. J. Env. Pollut.*, 22(1-2) 17-28

##### **2005**

2. Bocquet, M. (2005). Grid resolution dependence in the reconstruction of an atmospheric tracer source. *Nonlinear Process in Geophysics*, 12:219-234
3. Bocquet, M. (2005). Reconstruction of an atmospheric tracer source using the principle of maximum entropy I : Theories. *Quart. J. Roy. Meteor. Soc.*, 131(Part B(610)):2191-2208
4. Bocquet, M. (2005). Reconstruction of an atmospheric tracer source using the principle of maximum entropy II : Applications. *Quart. J. Roy. Meteor. Soc.*, 131(Part B(610)):2209-2223
5. Issartel, J.-P. (2005). Emergence of a tracer source from air concentration measurements: a new strategy for linear assimilation. *Atmos. Chem. Phys.*, 5:249-273
6. Mallet, V., Sportisse, B. (2005). A comprehensive study of ozone sensitivity with respect to emissions over Europe with a chemistry-transport model. *J. Geophys. Res.*, 110(D22)
7. Quélo, D., Mallet, V., Sportisse, B. (2005). Inverse modeling of NOx emissions at regional scale over Northern France. Preliminary investigation of the second-order sensitivity. *J. Geophys. Res.*, 110(D24310)
8. Quélo, D., Sportisse, B., Isnard, O. (2005). Data assimilation for short-range dispersion of radionuclides: a case study for second-order sensitivity. *J. Environ. Radioactivity*, 84:393-408
9. Sartelet, K. N., Hayami, H., Albriet, B., Sportisse, B. (2005). Development and preliminary validation of a Modal Aerosol Model for tropospheric chemistry: MAM. *Aerosol Sci. Technol.*, 40(2):118-127

##### **2006**

10. Debry, E., Sportisse, B. (2006). Reduction of the condensation/evaporation dynamics for atmospheric aerosols: theoretical and numerical investigation of hybrid methods. *J. Aerosol Sci.*, 37(8):950-966
11. Krysta, M., Bocquet, M., Sportisse, B., Isnard, O. (2006). Data assimilation for short-range dispersion of radionuclides: an application to wind tunnel data. *Atmos. Env.*, 40(38):7267-7279
12. Mallet, V., Sportisse, B. (2006). Ensemble-based air quality forecasts: a multi-model approach applied to ozone. *J. Geophys. Res.*, 111(D18):18302
13. Mallet, V., Sportisse, B. (2006). Uncertainty in a chemistry-transport model due to physical parameterizations and numerical approximations: an ensemble approach applied to ozone modeling. *J. Geophys. Res.*, 111(D01302)
14. Roustan, Y., Bocquet, M. (2006). Sensitivity analysis for mercury over Europe. *J. Geophys. Res.*, 111(D14304) 56
15. Roustan, Y., Bocquet, M. (2006). Inverse modeling for mercury over Europe. *Atmos. Chem. Phys.*, 6:3085-3098

## 2007

16. Bocquet, M. (2007). High resolution reconstruction of a tracer dispersion event: application to ETEX. *Quart. J. Roy. Meteor. Soc.*, 33: 1013-1026
17. Bouzereau, E., Musson-Genon, L., Carissimo, B. (2007). On the definition of the cloud water content fluctuations and its effects on the computation of a second-order liquid water correlation. *J. Atmos. Sci.*, 64:665-669
18. Davoine, X., Bocquet, M. (2007). Inverse modelling-based reconstruction of the Tchernobyl source term available for long-range transport. *Atmos. Chem. Phys.*, 7:1549-1564
19. Debry, E., Fahey, K., Sartelet, K., Sportisse, B., Tombette, M. (2007). A new Size REsolved Aerosol Model: SIREAM. *Atmos. Chem. Phys.*, 7(6):1537-1547
20. Debry, E., Sportisse, B. (2007). Numerical simulation of the General Dynamics Equation (GDE) for aerosols with two collocation methods. *Appl. Numer. Math.*, 57(8):885-898
21. Debry, E., Sportisse, B. (2007). Solving aerosol coagulation with size-binning methods. *Appl. Numer. Math.* doi:10.1016/j.apnum.2006.09.007, 57(9): 1008-1020
22. Krysta, M., Bocquet, M. (2007). Source reconstruction of an accidental radionuclide release at European scale. *Quart. J. Roy. Meteor. Soc.*, 133:529-544
23. Mallet, V., Pourchet, A., Quélo, D., Sportisse, B. (2007). Investigation of some numerical issues in a Chemistry-Transport Model: gas-phase simulations. *J. Geophys. Res.*, 112, D15301, doi:10.1029/2006JD008373.
24. Mallet, V., Quélo, D., Sportisse, B., Ahmed de Biasi, M., Debry, E., Korsakissok, I., Wu, L., Roustan, Y., Sartelet, K., Tombette, M., Foudhil, H. (2007). Technical Note: The air quality modeling system PolypheMUS. *Atmos. Chem. Phys.*, 7, 5479-5487, 2007
25. Milliez, M., Carissimo, B. (2007). Numerical simulations of flow and pollutant dispersion in an idealized urban area, for different meteorological conditions. *Boundary-Layer Meteor.*, 122(2):321{342
26. Musson-Genon, L., Dupont, E., Wendum, D. (2007). Reconstruction of the surface boundary layer vertical structure of wind temperature and humidity at two levels. *Boundary-Layer Meteor.* 124(2):235-250
27. Quélo, D., Krysta, M., Bocquet, M., Isnard, O., Minier, Y., Sportisse, B. (2007). Validation of the polypheMUS system: the ETEX, Chernobyl and Algeciras cases. *Atmos. Env.* doi:10.1016/j.atmosenv.2007.02.035 57
28. Sartelet, K., Debry, E., Fahey, K., Tombette, M., Roustan, Y., Sportisse, B. (2007). Simulation of aerosols and gas phase species over Europe with the PolypheMUS system. Part I: model-to-data comparison for year 2001. *Atmos. Env.* 41(29):6,116-6,131
29. Sartelet, K., Hayami, H., Sportisse, B. (2007). Dominant aerosol processes during high-pollution episodes over Greater Tokyo. *J. Geophys. Res.* 112, D14214, doi:10.1029/2006JD007885
30. Sartelet, K., Hayami, H., Sportisse, B. (2007). MICS-Asia Phase II: sensitivity to the aerosol module. *Atmos. Env.* 42(15):3,562-3,570
31. Sportisse, B. (2007). A review of current issues in air pollution modeling and simulation. *Computational Geosciences*, 11(2):159-181
32. Sportisse, B. (2007). A review of parameterizations for modeling dry deposition and scavenging of radionuclides. *Atmos. Env.*, 41(13):2683-2698
33. Sportisse, B., Djouad, R. (2007). Use of Proper Orthogonal Decompositions for the reduction of atmospheric chemistry. *J. Geophys. Res.*, 112(D06303)
34. Sportisse, B., Quélo, D., Mallet, V. (2007). Impact of mass consistency errors for atmospheric dispersion. *Atmos. Env.* 41(29):6,132-6,142
35. Tombette, M., Sportisse, B. (2007). Aerosol modeling at regional scale: Model-to-data comparison and sensitivity analysis over Greater Paris. *Atmos. Env.*, 41(33):6,941-6,950
36. Grazzini J., Turiel A., Yahia H., Herlin I. (2007) A multifractal approach for extracting relevant textural areas in satellite meteorological images. *Environ. Modeling Software*, 22(3): 323-334

37. Chrysoulakis, N., Herlin, I., Prastacos., P., Yahia, H., Grazzini, J., Cartalis, C. (2007) An improved algorithm for the detection of plumes caused by natural or technological hazards using AVHRR imagery, *Remote Sensing Environ.* 108(4): 393-406

## 2008

38. Milliez, M., Carissimo, B. (2008). CFD modelling of concentration fluctuations in an idealized urban area.. *Boundary-Layer Meteorol.* 127(2):241-259
39. Demael E, B. Carissimo (2008) Comparative evaluation of an Eulerian CFD and Gaussian plume models base on Prairie Grass Dispersion Experiment. *J. Appl. Meteor. Climatol.*, 47, 888-900
40. Sartelet, K., Hayami, H., Sportisse, B. (2008). MICS-Asia Phase II: sensitivity to the aerosol module. *Atmos. Env.* 42(15):3,562-3,570
41. Han, Z., Sakurai, T., Ueda, H., Carmichael, G.R., Streets, D., Hayami, H., Wang, Z., Holloway, T., Engardt, M., Hozumi, Y., Park, S.U., Kajino, M., Sartelet, K., Fung, C., Bennet, C., Thongboonchoo, N., Tang, Y., Chang, A., Matsuda, K., Amann, M. (2008). MICSAsia II: Model intercomparison and evaluation of ozone and relevant species. *Atmos. Env.*, 42(15):3,491-3,509
42. Bouzereau, E., L. Musson Genon, B. Carissimo, 2008: Application of a semi-spectral cloud water parameterization to cooling tower plume simulations. *Atmos. Res.*, doi:10.1016/j.atmosres.2008.04.006
43. Carmichael G.R., Sakurai T., Streets D., Hozumi Y., Ueda H., Park S.U., Fung C., Han Z., Kajino M., Engardt M., Bennet C., Hayami H., Sartelet K., Holloway T., Wang Z., Kannari A., Fu J., Matsuda M., Thongboonchoo N., Amann M. (2008), MICS-Asia II: The Model Intercomparison Study for Asia Phase II, Methodology and Overview of Findings. *Atmos. Environ.*, 42(15). doi:10.1016/j.atmosenv.2007.04.007.
44. Holloway T., Sakurai T., Han Z., Ehlers S., Spak S.N., Horowitz L.W., Carmichael G.R., Streets D.G., Hozumi Y., Ueda H., Park S.U., Fung C., Kajino M., Thongboonchoo N., Engardt M., Bennet C., Hayami H., Sartelet K., Wang Z., Matsuda K., Amann M. (2008) MICS-Asia II: Impact of global emissions on regional air quality in Asia. *Atmos. Environ.*, 42(15). doi:10.1016/j.atmosenv.2007.10.022.
45. Hayami H., Sakurai T., Han Z., Ueda H., Carmichael G.R., Streets D., Holloway T., Wang Z., Thongboonchoo N., Engardt M., Bennet C., Fung C., Chang A., Park S.U., Kajino M., Sartelet K., Matsuda K., Amann M. (2008) MICS-Asia II: Model intercomparison and evaluation of particulate sulfate, nitrate and ammonium. *Atmos. Environ.*, 42(15). doi:10.1016/j.atmosenv.2007.08.057
46. Abida R., Bocquet, M., Vercauteren, N., Isnard, O. (2008). Design of a monitoring network over France in case of a radiological accidental release. *Atmos. Env.*, 42: 5205-5219.
47. Bocquet, M. (2008). Inverse modelling of atmospheric tracers: Non-Gaussian methods and second-order sensitivity analysis. *Nonlin. Processes Geophys.*, 15, 127-143
48. Yahia H., Turiel A., Chrysoulakis N.; Grazzini J., Prastacos P., Herlin I. (2008) Application of the multifractal microcanonical formalism to the detection of fire plumes in NOAA-AVHRR data, *Int. J. Remote Sensing*, 29(14): 4189-4205
49. Korotaev G.K., Huot E., Le Dimet F.X., Herlin I., Stanichny S.V., Solovyev D.M., Wu L. (2008) Retrieving ocean surface current by 4-D variational assimilation of sea surface temperature images, *Remote Sensing Environ.* 112(4): 1464-1475
50. Wu L., Mallet V., Bocquet, M., Sportisse, B. (2008). A Comparison Study of Data Assimilation Algorithms for Ozone Forecasts. *J. Geophys. Res. (Atmospheres)*. In press.
51. Mallet, V., Sportisse, B. (2008). Air quality modeling: from deterministic to stochastic modeling. *Computers and Mathematics with Application. sous presse*
52. Krysta M., Bocquet M., Brandt J. (2008). Probing ETEX-II data set with inverse modelling. *Atmos. Chem. Phys.*, 8: 3963-3971.

53. Queguiner S., Ciffroy P., L. Musson Genon: Multimedia modelling of the exposure to cadmium and lead in the atmosphere – Application to industrial releases in a Mediteranean region and uncertainty/sensitivity analysis. Water Air Soil Pollut., sous presse.
54. Mallet V., Stolmtz G., Mauricette B. (2008) Ozone ensemble forecast with machine learning algorithms. J. Geophys. Res., sous presse
55. Jörg F., Hellsten A., Schlünzen K.H., Carissimo B. (2008) The COST 732 best practice for CFD simulation of flows in the urban environment – A summary. Int. J. Environ. Pollut., sous presse.

## **2.1.2 Articles dans des revues avec comité de lecture non répertoriées dans des bases de données internationales (ACLN)**

1. Roustan, Y., Bocquet, M., Musson-Genon, L., Sportisse, B. (2006). Modélisation du mercure, du plomb et du cadmium à l'échelle du continent européen. Pollution Atmosphérique, (191):317-327
2. Bocquet, M., Sportisse, B. (2007). Modélisation inverse pour la qualité de l'air : éléments de méthodologie et exemples. Pollution Atmosphérique, (196) : 395-404
3. Mallet, V., Quélo, D., Sportisse, B., Korssakissok I. (2007). Polypheus : Une plate-forme multimodèles pour la pollution atmosphérique et l'évaluation des risques. Pollution Atmosphérique, (196) : 423-434

## **2.1.3 Articles dans des revues sans comité de lecture (ASCL)**

1. Mallet, V., Sportisse, B. (2004). 3D Chemistry-Transport Model Polair3D: numerical issues, validation and automatic-differentiation strategy. Atmos. Chem. Phys. Discuss., 4 (1):1371:1392
2. Torres, G.A., Unger, S., Asselmeyer-Maluga, T., Mallet, V., Quélo, D., Sportisse, B., Herlin, I., Berroir, J.-P. (2005). Data assimilation and air pollution forecasting: The Berlin case. ERCIM News, 61(4): 20-21.
3. M. Tombette, P. Chazette,, B. Sportisse (2008). Simulation of aerosol optical properties over Europe with a 3-D size-resolved aerosol model: comparisons with AERONET data Atmos. Chem. Phys. Discuss., 8, 1321-1365.

## **2.1.4 Communications (ACT, COM & AFF)**

### **2004**

1. Krysta, M., Bocquet, M., Isnard, O., Issartel, J., and Sportisse, B. (2004). Data Assimilation of Radionuclides at Small and Regional Scale. Some preliminary results. In Proceedings of the NATO ARW. Kluwer
2. Quiroz, H., Gallardo-Klenner, L., and Issartel, J.-P. (2004). Assimilation de données, un révélateur de la qualité des modèles : exemple de l'arsenic minier à Santiago du Chili. In Atelier de Modélisation Atmosphérique. Météo-France
3. Sartelet, K., Hayami, H., Albriet, B., and Sportisse, B. (2004). A new modal model of atmospheric aerosols (MAM). In Proceedings of the ICNAA Conference
4. Sartelet, K. N. and Hayami, H. (2004). Application of the 3D CTM Polair to air quality over Greater Tokyo. In Proceedings of the 45th annual meeting of Japan Society for Atmospheric Environmentnment
5. Roustan, Y., Bocquet, M., Musson-Genon, L., and Sportisse, B. (2004). Modelling Mercury over Europe with the Chemistry-Transport-Model Polair3D. In Proceedings of the GLOREAM/EURASAP Workshop. DMI. Denmark
6. Fahey, K., Debry, E., Foudhil, H., and Sportisse, B. (2004). Formulation, development and preliminary validation of the Size Resolved Aerosol Model (SIREAM). In Proceedings of the GLOREAM/EURASAP Workshop. DMI. Denmark

7. Bouzereau, E., Musson-Genon, L., Dupont, E. and Carissimo, B. (2004). Application of a semi-spectral cloud water parameterization to cooling tower plumes, EGU General Assembly, 25-30 avril 2004, Nice.

## 2005

8. Taghavi, M., Fahey, K., Foudhil, H., and Sportisse, B. (2005). Modelling aerosols with the POLAIR3D/SIREAM model on the mesoscale over an urban area in south-eastern France (ESCOMPTE campaign). In Proceedings of the European Aerosol Conference. Belgium
9. Demael, E. and Carissimo, B. (2005). 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, July 18-20, 2005, Fairfax, USA
10. Taghavi, M. and Musson-Genon, L. (2005). Impact of thermal power plant emissions in Marseille. In Power-Gen Europe Conference. Milan
11. Taghavi, M. (2005). Intermediate species: does chemistry work in a same way in all models? In Sixth ESCOMPTE Workshop. Marseille
12. Bocquet, M. and Krysta, M. (2005). Inverse Modelling of Passive Atmospheric Tracers Using Entropy-based Methods: Methodological Aspects. In Dimet, F.-X. L. and B.Sportisse, editors, Proceedings of the Workshop CEA-EDF-INRIA: Data assimilation and inverse modelling in geosciences
13. Krysta, M., Bocquet, M., and Quélo., D. (2005). Source reconstruction for accidental releases of radio-elements. In Proceedings of NATO Advanced Research Workshop. Tabakhmela, Georgia
14. Fahey, K., Debry, E., Foudhil, H., and Sportisse, B. (2005). The incorporation of Aerosol processes in Polair3D. In Proceedings of Gloream 2004
15. Boutahar, J. and Sportisse, B. (2005). Reduction methods and uncertainty propagation: Application to a Chemistry-Transport Model. In Proceedings of the TAM/TAM Conférence. Tunis
16. Tombette, M., Fahey, K., Debry, E., and Sportisse, B. (2005a). Aerosol modelling at regional scale: a sensitivity study with the Polyphemus platform. In Builtjes, P., editor, Proceedings of Gloream 2005. TNO. Apeldoorn, The Netherlands
17. Krysta, M. and Bocquet, M. (2005). Inverting sources of an accidental radionuclide release at continental scale. In Builtjes, P., editor, Proceedings of Gloream 2005. TNO. Apeldoorn, The Netherlands
18. Sartelet, K. and Hayami, H. (2005). MICS. Asia Phase II: sensitivity to the aerosol module. In Proceedings of the workshop of the Japanese atmospheric environmental society., Nagoya, Japan
19. Sartelet, K., Hayami, H., and Sportisse, B. (2005a). Application of Polair3D to the model inter-comparison study MICS-Asia Phase II for March 2001. In Proceedings of MICS Asia 7th workshop, IIASA. Laxenburg, Austria
20. Isnard, O., Krysta, M., Bocquet, M., Dubiau, P., and Sportisse, B. (2005). Data assimilation of radionuclides atmospheric dispersion at small scale: a tool to assess the consequences of radiological emergencies. In Proceedings of the IAEA Conference. Rio, Brazil

## 2006

21. Joumard, R., Laurikko, J., Geivanidis, S., Samaras, Z., Olàh, Z., Weilenmann, M., André, J., Cornelis, E., Gribé, M., Lacour, S., Prati, M., Vermeulen, R., and Zallinger, M. (2006). Accuracy of exhaust emissions measurements on vehicle bench. In FISITA 2006, World Automotive Congress. Yokohama, Japan
22. Lacour, S., Ventura, A., Rangod, N., Carissimo, B., and Jullien, A. (2006a). How to estimate roadworks emissions factors from tra\_c and air quality monitoring measurements - A methodological approach. In Proceedings of the 15th Workshop Transport and Air Pollution. Reims, France
23. Lagache, R., Declercq, C., Sportisse, B., Quélo, D., Palmier, P., Quetelard, B., and Haziak, F. (2006b). Evaluation de l'impact du plan de déplacements urbains de Lille-Métropole sur le trafic, les

- concentrations de polluants atmosphériques et la mortalité. In Proceedings of the 15th Workshop Transport and Air Pollution. Reims, France
24. Mallet, V. and Sportisse, B. (2006c). Peut-on modéliser la qualité de l'air de manière déterministe ? In Proceedings of "38<sup>èmes</sup> Journées de Statistique". SMS. Paris
  25. Milliez, M., Musson-Genon, L., and Carissimo, B. (2006b). Validation of a radiative scheme for CFD modeling of heat transfers between buildings and owin urban canopies. In Preprints of the 6th International Conference on Urban Climate. Goteborg, Sweden 60
  26. Milliez, M., Musson-Genon, L., and Carissimo, B. (2006a). Radiative transfers in CFD modeling of the urban canopy. In Proceedings of the 28th NATO International Technical Meeting on Air Pollution Modeling and its Applications. Leipzig, Germany
  27. Bocquet M. Monitoring of Air Quality in the Boundary Layer and Data Assimilation at Regional Scales (2006). In Proceedings of the ACCENT/WMO Expert Workshop in support of IGACO: "Chemical Data Assimilation for the Observation of the Earth's Atmosphere", Geneva.
  28. Demael, E. and Carissimo, B. (2006). CFD simulations of accidental releases on nuclear plant. 10th Annual George Mason University Conference on "Atmospheric Transport and Dispersion Modeling, August 1-3, 2006, Fairfax, USA.
  29. Milliez, M. and B. Carissimo, (2006c). CFD Modeling of concentration fluctuations in an idealized urban area, 10<sup>th</sup> annual George Mason University conference on "Atmospheric Transport and Dispersion Modeling", August 1-3, 2006, Fairfax, USA.

## 2007

30. Quéguiner, S., Roustan, Y., and Ciffroy, P. (2007). Coupling Of Atmospheric Model And Multimedia Model For The Exposure To Heavy Metal Released In The Atmosphere – Application To Industrial Releases In A Mediterranean Region. In Proceedings of the 11<sup>th</sup> conference on Harmonisation within Atmospheric Dispersion Modelling for Ragulatory Purposes. Cambridge, United Kingdom.
31. Dupont, E. and Flori, J.P. (2007). Comparison of sodars with ultrasonic and cup anemometers for wind energy applications. In proceedings of the European Wind Energy Conference, Milan.
32. Challet J., Carissimo B., Dupont E., Musson-Genon, Samba C. (2007) : Premières applications du schéma microphysique de Mercure\_Saturne à la simulation du brouillard. Journée Scientifique du SIRTA, 23 janvier 2007.
33. Espana G., Aubrun S., Devinant P., Laporte L., Dupont E. (2007): Properties of the far wake of a wind turbine in an atmospheric boundary layer. Physmod conference, Orléans.
34. Laporte L, Dupont E. (2007): Application of atmospheric CFD to wind resource assessment and to wake effect characterisation. Séminaire European Association of Wind Energy, Pamplune.
35. Sartelet K., Debry E., Tombette M., Roustan Y., Sportisse B. (2007) Aerosol modeling at regional and continental scales 6th Annual CMAS Conference, October 1-3, 2007 Chapel Hill, USA. [http://www.cmascenter.org/conference/2007/abstracts/sartelet\\_session8\\_2007.pdf](http://www.cmascenter.org/conference/2007/abstracts/sartelet_session8_2007.pdf)
36. Debry, E. and Seigneur, C. (2007) Tracking organic particulate matter in Europe with the Polyphemus system. AAAR Annual Conference, 24-28 September 2007, Reno, Nevada, USA, in 2007 AAAR annual conference abstract.
37. Albriet, A. and Sartelet, K. (2007) Numerical CFD Modelling of the Formation of an Aerosol Distribution close to a Car Traffic Linked Source. AAAR Annual Conference, 24-28 September 2007, Reno, Nevada, USA, in 2007 AAAR annual conference abstract.
38. Sartelet K. Debry E. (2007) The Sectional and Modal Aerosol Models SIREAM and MAM in the Air Quality Platform Polyphemus: Common Features and Differences. , in Abstracts of IAMA conference, 6-7 December 2007, UC Davis, USA. <http://mae.ucdavis.edu/wexler/IAMA/ppts/VA/sartelet-iama.pdf>

39. Debry E., Seigneur C. Sartelet K. (2007) Organic aerosols in the air quality platform Polyphemus: oxidation pathways, hydrophilic/hydrophobic partitioning and oligomerization, in Abstracts of IAMA conference, 6-7 December 2007, UC Davis, USA.
40. Albriet, A. and Sartelet, K. (2007) Numerical CFD Modelling of the Formation of an Aerosol Distribution close to a Traffic Linked Source. 18th EFCA International Symposium Forschungszentrum Karlsruhe FZK, Germany. June 11 and 12, 2007
41. El Abed A., Dubuisson S., Bereziat D. Association spatio-temporelle avec données manquantes par minimisation d'énergie. In GRETSI, septembre 2007, pp. 65-68, Troyes
42. El Abed A., Dubuisson S., Bereziat D. Energetic particle filter for online multiple target tracking. In proceedings of ICIP (international conference on image processing), september 2007, pp. 493-496, San Antonio, USA
43. El Abed A., Dubuisson S., Bereziat D. Energy minimization approach for online data association with missing data. In VISAPP'07, March 8-11<sup>th</sup> 2007, pp. 371-378, Barcelona
44. El Abed A., Dubuisson S., Bereziat D. ENMIM : Energetic normalized mutual information model for online multiple object tracking with unlearned motions. In ACVIS, August 2007, pp. 955-967, Delft, The Netherlands
45. Huot E., Xu Y., Korotaev G., Wu L., Herlin I., Le Dimet F.-X. Estimation de vitesses par assimilation de données variationnelle. In proceedings of colloque GRETSI, July 2007, pp. 1285-1288, Troyes
46. Isambert T., Herlin I., Berroir J.-P. Fast and stable vector spline method for fluid flow estimation. In proceedings of ICIP (international conference on image proceeding), September 16-17<sup>th</sup> 2007, pp. 505-508, San Antonio, USA
47. Korotaev G., Huot E., Le Dimet F.-X., Herlin I., Stanichny S. V., Solovyev D. M. Analysis of the black sea surface currents retrieved from space imagery. In rapport du 38ème congrès de la commission internationale pour l'exploration scientifique de la mer Méditerranée, 2007, vol. 38
48. Rekik W., Bereziat D., Dubuisson S. 3D+t reconstruction in the context of locally spheric shaped data observation. In 12<sup>th</sup> international conference on computer analysis of images and patterns (CAIP), August 2007, pp. 482-489, Vienna
49. Teina R., Bereziat D., Stoll B. Etude de la cocoteraie de tikehau sur des images ikonos. In majectSTIC, August 2007, pp. 265-269
50. Yahia H., Turiel A., Chrysoulakis N., Grazzini J., Prastacos P., Herlin I. Multifractal pre-processing of avhrr images to improve the determination of smoke plumes from large fire. In IEEEIGARSS'07, July 2007, Barcelona
51. Demael, E. and Carissimo, B. (2007): Local atmospheric dispersion modelling of trace constituents issued from a nuclear power plant: A comparison using a CFD code and ADMS with wind tunnel data. 11<sup>th</sup> conference on “Harmonization within Atmospheric Dispersion Modelling for Regulatory Purposes”, Cambridge, UK, July 2-5, 2007.
52. Milliez, M., Musson Genon, L., and Carissimo, B., (2007). CFD modelling of flow and pollutant dispersion in urban areas, taking into account the radiative effects of the buildings. 11<sup>th</sup> conference on “Harmonization within Atmospheric Dispersion Modelling for Regulatory Purposes”, Cambridge, UK, July 2-5, 2007.
53. Demael, E., Bilbault, D. and Carissimo, B. (2007). Uncertainty propagation and sensitivity analysis for CFD simulations of accidental release on nuclear power plant. 11th Annual George Mason University Conference on “Atmospheric Transport and Dispersion Modeling, July 10-12, 2007, Fairfax, USA
54. Demael, E., Gilbert, E. and Carissimo, B. (2007). A comparison using a CFD code and ADMS with tunnel data for the modelling of dispersion around nuclear power plant. 11th Annual George Mason University Conference on “Atmospheric Transport and Dispersion Modeling, July 10-12, 2007, Fairfax, USA

## **2008**

55. Debry E., Sartelet K., Seigneur C. (2008) Simulation à l'échelle européenne et régionale des aérosols organiques avec le système Polyphemus : modèle SIREAM/AEC, comparaison aux mesures et sensibilité aux paramètres. 23ème Congrès Français sur les Aérosols, 17-18 janvier 2008. Paris.
56. Sartelet K., Debry E., Tombette M., Roustan Y., Sportisse B. (2008). Gas and PM modeling at regional and continental scales. In Proceedings of MICS Asia 10th workshop, IIASA. Laxenburg, Austria
57. Tombette M., Chazette P., Sportisse B., Sartelet K., Debry E. (2008) Evaluation of a mesoscale aerosol model over Europe and Greater Paris with chemical and optical data from AERONET and LISAIR campaign, EGU General Assembly, Vienna, Austria, 13-18 April 2008.
58. Laporte L., Dupont E., Carissimo B., Musson-Genon L., Sécolier C. : Downscaling the wind energy resource on a complex terrain with a forest canopy using an atmospheric CFD code. European Wind Energy Conference, Bruxelles, 2008.
59. Espana G., Laporte L., Aubrun S., Devinant P., Dupont E. : Wind turbine wake characteristics in an atmospheric boundary layer: far wake physical and numerical modelling. European Wind Energy Conference, Bruxelles, 2008.
60. Lecreurer B., Dupont E., Musson-Genon L., Carissimo B. (2008) : Modélisation à micro-échelle des hétérogénéités spatiales de l'écoulement sur le site du SIRTA, avec le code Mercure\_Saturne : étude préliminaire. Atelier de Modélisation de l'Atmosphère, Toulouse, 21-23 January 2008.
61. Lecreurer B., Dupont E., Musson-Genon L., Carissimo B. (2008) : Modélisation à micro-échelle des hétérogénéités spatiales de l'écoulement sur le site du SIRTA, avec le code Mercure\_Saturne : premiers résultats. Journée Scientifique du SIRTA, 27 Mars 2008.
62. Zhang, X., Challet, J., E. Dupont and L. Musson Genon (2008): Modélisation 1-D du brouillard avec le code Mercure-Saturne : application à la campagne ParisFog, Atelier de Modélisation de l'Atmosphère, Toulouse, 21-23 janvier 2008
63. Milliez, M., Musson Genon, L., and Carissimo, B., (2008). CFD modeling of the urban canopy with thermal effects : Application to MUST container wall temperature evolution. 12<sup>th</sup> annual George Mason University conference on “Atmospheric Transport and Dispersion Modeling”, July 8-10, 2008, Fairfax, USA

## **2.1.5 Ouvrages scientifiques (OS)**

1. Sportisse, B. (2007) Chapitre 6.2: Partenariat recherche publique/entreprise : l'exemple du CEREA, Laboratoire Commun ENPC/EDF R&D, In Management de la recherche – Enjeux et perspectives, R. Barré, B. de Laat et J. Theys, eds., 392 pp., De Boeck, Bruxelles, Belgique
2. Sportisse, B. (2008) Pollution atmosphérique – Des processus à la modélisation, 345 pp., Springer-Verlag France, Paris

## **2.1.6 Rapports (AP)**

### **2004**

1. Rapport 2004-1: B. Sportisse. Rapport de synthèse des travaux réalisés dans le cadre de la convention EDF/ENPC pour l'année 2003. 9 pages.
2. Rapport 2004-2: W. Moufouma-Okia and S. Lacour. Modélisation de la qualité de l'air en région PACA et effets de scénario de transport sur des épisodes photochimiques. Rapport de contrat DRAST. 31 pages.

3. Rapport 2004-3: S. Lacour. Modélisation de la pollution atmosphérique et des impacts l'échelle locale en interaction avec le RST. Rapport de contrat DRAST. 15 pages.
4. Rapport 2004-4: W. Moufouma-Okia, L. Musson-Genon and B. Sportisse. Etude de l'impact des missions de la centrale de Martigues sur la pollution photo-oxydante en région PACA. Rapport de contrat Mission Thermique EDF. 40 pages.
5. Rapport 2004-5: S. Lacour and B. Carissimo. Modélisation de la dispersion réactive des oxydes d'azote à l'échelle locale avec Mercure. 44 pages.
6. Rapport 2004-6: Y. Roustan. Modélisation de l'impact des métaux lourds, du mercure, et des particules (PM2.5, PM10) à l'échelle du continent Européen. Rapport d'avancement ADEME/EDF.30 pages.
7. Rapport 2004-7: L. Huynh. Impact des missions des avions sur la qualité de l'air autour des plates formes aéroportuaires. 51 pages.
8. Rapport 2004-8: B. Sportisse. Rapport de synthèse des travaux réalisés dans le cadre du Projet Assimilation de Données pour le PNCA. 23 pages.
9. Rapport 2004-9: M. Krysta. Projet MIRA. Rapport d'avancement. Rapport de contrat IRSN. 20 pages.
10. Rapport 2004-10: M. Krysta, M. Bocquet, O. Isnard, J.-P. Issartel and B. Sportisse. Data Assimilation of Radionuclides at Small and Regional Scale. Some preliminary results. 10 pages.
11. Rapport 2004-11: V. Picavet. Code, tools and methods at CEREA. 26 pages.
12. Rapport 2004-12: G.A. Torrès. Documentation of MM5 to POLAIR.
13. Rapport 2004-13: D. Garreau and M. Joly. Modélisation inverse de l'accident de Tchernobyl. Rapport de stage scientifique ENPC. 53 pages.
14. Rapport 2004-14: T. Zebiouk : Panache sous-maille dans Polair3D. Rapport de stage DEA. 47 pages.
15. Rapport 2004-15: E. Debry and B. Sportisse. Reduction of the General Dynamics Equation for atmospheric aerosols: theoretical and numerical investigation. Preprint article submitted to Journal of Aerosol Science. 32 pages.
16. Rapport 2004-17: B. Sportisse. Etat d'avancement des travaux engagés dans le contexte de la convention cadre IRSN/CEREA. 4 pages.
17. Rapport 2004-18: M. Aissaoui. Etude de la propagation d'incertitudes dans un modèle de Chimie-Transport, Polair3D. Rapport de stage DEA M2SAP. 61 pages.
18. Rapport 2004-19: S. Lacour. Estimations de ratios moyens de NO<sub>2</sub>/NO<sub>x</sub> au voisinage du débouché d'un tunnel en tranche en milieu urbain. Rapport de contrat CETU. 16 pages.
19. Rapport 2004-20: T. Salameh. Modélisation de la dispersion atmosphérique réactive dans une rue. Rapport de stage DEA. 61 pages.
20. Rapport 2004-21: Chi-Sian Soh. Paramétrisation de la vitesse de dépôt sec pour un modèle de chimie-transport de polluants. Rapport de stage scientifique ENPC. 58 pages.
21. Rapport 2004-22: K. Sartelet. Modal aerosol model (MAM) - Technical description. 24 pages.
22. Rapport 2004-23: K.N. Sartelet, H. Hayami, B. Albriet and B. Sportisse. Development and preliminary validation of a new Modal Aerosol Model for tropospheric chemistry: MAM. Preprint article submitted to Aerosol Science and Technology. 17 pages.
23. Rapport 2004-24: B. Sportisse and D. Quélo. Assimilation de données. Partie I: Eléments théoriques. Notes de cours DEA M2SAP et ENSTA. 30 Pages.
24. Rapport 2004-25: D. Quélo and B. Sportisse. Assimilation de données. Partie II: Implémentation dans Polair3D. Notes de cours DEA M2SAP et ENSTA. 20 pages.
25. Rapport 2004-26: K. Fahey, H. Foudhil and B. Sportisse. Coupling the SIREAM model to Polair3D, preliminary results. 35 pages.
26. Rapport 2004-27: M. Taghavi, L. Musson-Genon and B. Sportisse. Impact des rejets de la centrale thermique de Martigues sur la qualité de l'air. Modélisation avec Polair3D. Rapport de contrat Mission Thermique EDF. 51 pages.

27. Rapport 2004-28: D. Quélo, R. Lagache and B. Sportisse. Etude de l'impact qualité de l'air des scénarios PDUs sur Lille l'aide du modèle de Chimie-Transport POLAIR3D. 22 pages.
28. Rapport 2004-29: V. Mallet. AtmoData Library: data processing and parameterizations in atmospheric sciences. 14 pages.
29. Rapport 2004-30: M. Bocquet. Reconstruction of an atmospheric tracer source using the principle of maximum entropy. I: Theory. Preprint article submitted to QJRMS. 19 pages.
30. Rapport 2004-31: M. Bocquet. Reconstruction of an atmospheric tracer source using the principle of maximum entropy. II: Applications. Preprint article submitted to QJRMS. 15 pages.
31. Rapport 2004-32: M. Bocquet. Grid resolution dependence in the reconstruction of an atmospheric tracer source. Preprint article submitted to Nonlinear Process in Geophysics. 15 pages.
32. Rapport 2004-33: H. Quiroz, L. Gallardo Klenner and J.-P. Issartel. Assimilation de données, un révélateur de la qualité des modèles: exemple de l'arsenic minier Santiago du Chili. In Proceedings of the 'Ateliers de Modélisation Atmosphérique' (Météo-France, Toulouse, 29-30 November 2004). 4 pages.
33. Rapport 2004-34: F. Lebrun. Etude des lois de la couche limite de l'atmosphère. Rapport de stage DEA/Ecole Centrale de Nantes. 53 pages.
34. Rapport 2004-35: S. Lacour. Modélisation de la pollution atmosphérique et des impacts à l'échelle locale en interaction avec le RST. Rapport de convention DRAST. 14 pages.
35. Rapport 2004-36: M. Krysta, M. Bocquet and B. Sportisse. Projet MIRA. Modélisation inverse sur la base des données de la soufflerie ECL. Rapport de contrat IRSN. 74 pages.

## 2005

36. Rapport 2005-1: B. Sportisse. Rapport d'avancement Convention Cadre CEREA/IRSN.
37. Rapport 2005-2: Y. Roustan. Modélisation de l'impact des métaux lourds, du mercure, et des particules PM2.5, PM10 à l'échelle du continent Européen. Rapport d'avancement ADEME. 32 pages.
38. Rapport 2005-3: K. Kata, H Hayami and B. Sportisse. Application of Polair3D to the modal inter-comparison study MICS-Asia Phase II for March 2001. 5 pages.
39. Rapport 2005-4: Y. Roustan, M. Bocquet, L. Musson-Genon and B. Sportisse. Modelling atmospheric mercury at European scale with the Chemistry Transport Model Polair3D. Proceedings of GLOREAM 2004. 11 pages.
40. Rapport 2005-5: M. Milliez and B. Carissimo. Numerical simulations of plume transport in an idealized urban air for different meteorological conditions. 4 pages.
41. Rapport 2005-6: S. Lacour. Analyse complémentaire des mesures réalisées au Landy. Rapport de contrat CETU. 19 pages.
42. Rapport 2005-7: B. Juhel. Mise en place d'une procédure d'imbrication et d'assimilation de données au sein du code Mercure Saturne. Rapport de stage DEA Ecole Centrale de Nantes. 81 pages.
43. Rapport 2005-8: B. Sportisse and V. Mallet. Calcul scientifique pour l'environnement. Notes de cours ENSTA 2004-2005. 72 pages.
44. Rapport 2005-9: B. Albriet. Rapport d'avancement de thèse. Modélisation de la dispersion d'une distribution d'aérosols à petite échelle. Rapport de contrat INERIS. 41 pages.
45. Rapport 2005-10: H. Njomgang, V. Mallet and L. Musson-Genon. AtmoData Scientific documentation. Version 1. 27 pages.
46. Rapport 2005-11: V. Mallet, D. Quélo and B. Sportisse. Software architecture of an ideal modelling platform in air quality. A first step: Polyphemus. 13 pages.
47. Rapport 2005-12: V. Mallet and B. Sportisse. Data processing and parameterizations in atmospheric chemistry and physics: the AtmoData library. 14 pages.
48. Rapport 2005-13: V. Mallet and B. Sportisse. Uncertainty in chemistry transport models due to physical parameterizations and numerical approximations: an ensemble approach. Preprint article submitted to JGR. 14 pages.

49. Rapport 2005-14: D. Quélo, V. Mallet and B. Sportisse. Inverse Modelling of NOx Emissions at regional scale over northern France. Preliminary investigation of the second order sensitivity. Preprint article submitted to JGR. 12 pages.
50. Rapport 2005-15: H. Foudhil. Modélisation des aérosols atmosphériques dans Polair3D: Notice d'utilisation des programmes. 14 pages.
51. Rapport 2005-16: K. Fahey, E. Debry, H. Foudhil and B. Sportisse. The incorporation of Aerosol processes in Polair3D. Proceedings of GLOREAM 2004. 12 pages.
52. Rapport 2005-17: K. Fahey, E. Debry, H. Foudhil and B. Sportisse. The incorporation of Aerosol processes in Polair3D. 29 pages.
53. Rapport 2005-18: J. Boutahar and B. Sportisse. Reduction methods and uncertainty propagation: Application to a Chemistry-Transport Model. Proceedings of the TAM/TAM Conference. 6 pages.
54. Rapport 2005-19: S. Lacour. Modèle eulérien de la dispersion réactive de gaz et de particules en champ proche. 31 pages.
55. Rapport 2005-20: V. Mallet and B. Sportisse. A comprehensive study of ozone sensitivity with respect to emissions over Europe with a chemistry transport model. Preprint article submitted to JGR. 14 pages.
56. Rapport 2005-21: B. Albriet. Les aérosols organiques secondaires. Vers une intégration du modèle de Griffin/Pun dans Polair3D. 11 pages.
57. Rapport 2005-22: Y. Roustan and M. Bocquet. Sensitivity analysis for mercury over Europe. Preprint article submitted to JGR. 12 pages.
58. Rapport 2005-23: J.-P. Issartel. Emergence of a tracer source from air concentration measurements, a new strategy for linear assimilation. Preprint article submitted to Atmos. Chem. Phys. Discuss. 25 pages.
59. Rapport 2005-24: D. Quélo, B. Sportisse and O. Isnard. Data assimilation for short range atmospheric dispersion of radionuclides: A case study of second-order sensitivity. Preprint article submitted to Journal of Environmental Radioactivity. 16 pages.
60. Rapport 2005-25: E. Debry and B. Sportisse. Solving aerosol coagulation with size-binning methods. Preprint article submitted to Applied Numerical Mathematics. 18 pages.
61. Rapport 2005-26: A. Pourchet, V. Mallet, D. Quélo and B. Sportisse. Some numerical issues in chemistry-transport models - a comprehensive study with Polyphemus. 171 pages.
62. Rapport 2005-27: M. Taghavi and L. Musson-Genon. Impact of thermal power plant emission in Marseille. 15 pages.
63. Rapport 2005-28: E. Bouzereau, L. Musson-Genon and B. Carrissimo. On the definition of the cloud water content fluctuations and their effect on the computation of a second order liquid water correlation. Preprint article submitted to J. Atmos. Sciences. 16 pages.
64. Rapport 2005-29: B. Sportisse. Quelques éléments de paramétrisations du dépôt sec et du lessivage humide pour les runs Tchernobyl de Polyphemus/Polair3D. Rapport de contrat IRSN. 35 pages.
65. Rapport 2005-30: S. Lacour. Resuspension de radionucléides. Rapport de contrat CEA. 66 pages.
66. Rapport 2005-31: S. Lacour. Cours de pollution atmosphérique ENPC: dispersion locale de polluants. 53 pages.
67. Rapport 2005-32: Numéro de rapport non attribué (Number non allotted).
68. Rapport 2005-33: J. Puerta. Modélisation du brouillard à l'aide du modèle météorologique de mésoscale Mercure. Stage de fin d'études Centrale Marseille. 56 pages.
69. Rapport 2005-34: F. Rauwel. Installation et validation d'une chaîne de modélisation et simulation numérique de la qualité de l'air: application à un cas Européen. Rapport de stage scientifique ENPC. 68 pages.
70. Rapport 2005-35: H. Njomgang. Prévision opérationnelle de la qualité de l'air. Rapport de stage long. ENSTA. 92 pages.

71. Rapport 2005-36: E. Demael. Simulation de la campagne de mesures Prairie Grass à l'aide du code Mercure\_Saturne. Rapport d'avancement de thèse. 104 pages.
72. Rapport 2005-37: V. Mallet and B. Sportisse. Toward ensemble-based air-quality forecasts. Preprint article submitted to JGR. 11 pages.
73. Rapport 2005-38: E. Dupont, M.L. Courty and B. Carissimo. Modélisation du champ de vent et de turbulence sur le site CNPE de Cruas avec le Code Mercure Saturne. 38 pages.
74. Rapport 2005-39: A. Pourchet. Enjeux numériques dans les modèles de Chimie-Transport. Rapport de stage. ENSTA. 24 pages.
75. Rapport 2005-40: M. Bocquet and M. Krysta. Inverse Modelling of Passive Atmospheric Tracers Using Entropy-based Methods: Methodological Aspects. In Proceedings of the Workshop CEA-EDF-INRIA: Data assimilation and inverse modelling in geosciences. F.-X. Le Dimet and B. Sportisse Eds. 25 pages.
76. Rapport 2005-41: M. Krysta, M. Bocquet and D. Quélo. Source Reconstruction for Accidental Releases of Radio-elements. In Proceedings of NATO Advanced Research Workshop, Tabakhmela, Georgia. 8 pages.
77. Rapport 2005-42: V. Picavet. Technical notes on parallel Polair3D. 11 pages.
78. Rapport 2005-43: Y. Roustan. Modélisation du mercure à l'échelle du continent Européen. I. Paramétrisations. 33 pages.
79. Rapport 2005-44: Y. Roustan. Modélisation du mercure à l'échelle du continent Européen. II. Simulations. 19 pages.
80. Rapport 2005-45: Y. Roustan. Modélisation du plomb et du cadmium à l'échelle du continent Européen. I. Paramétrisations. 18 pages.
81. Rapport 2005-46: Y. Roustan. Modélisation du plomb et du cadmium à l'échelle du continent Européen. II. Simulations. 18 pages.
82. Rapport 2005-47: Y. Roustan, M. Bocquet, L. Musson-Genon and B. Sportisse. Modélisation du mercure, du plomb et du cadmium l'échelle Européenne. Preprint article submitted to Pollution Atmosphérique. 20 pages.
83. Rapport 2005-48: H. Foudhil and B. Carissimo. Gestion du Code Mercure Saturne par CVS. 29 pages.
84. Rapport 2005-49: S. Lacour. Estimation de la distribution des concentrations horaires annuelles et de leur variabilité à partir d'un nombre limité de simulations. Rapport de contrat CETU.35 pages.
85. Rapport 2005-50: M. Tombette, K. Fahey, K. Sartelet and B. Sportisse. Aerosol modelling at regional scale: a sensitivity study with the Polyphemus platform. In Proceedings of GLOREAM 2005. 9 pages.
86. Rapport 2005-51: B. Sportisse and V. Mallet. Calcul Scienti\_que pour l'Environnement. Notes de Cours ENSTA 2005-2006. 86 pages.
87. Rapport 2005-52: B. Albriet. Modélisation de la dispersion des aérosols à petite échelle. 36 pages.
88. Rapport 2005-53: H. Foudhil and L. Musson-Genon. Modélisation des panaches humides. Note de principe pour l'incorporation dans Polyphemus. Rapport de contrat INERIS. 21 pages.
89. Rapport 2005-54: B. Sportisse. Partenariat recherche publique/entreprise: l'exemple du CREA, Laboratoire Commun ENPC/EDF R&D. 13 pages.
90. Rapport 2005-55: M. Milliez and B. Carissimo. Numerical simulations of pollutant dispersion in an idealized urban area for different meteorological conditions. Preprint article submitted to B.L.M. 46 pages.
91. Rapport 2005-56: E. Debry and B. Sportisse. Numerical simulation of the General Dynamics Equation (GDE) for aerosols with two collocation methods. Preprint article submitted to Applied Numerical Mathematics. 22 pages.
92. Rapport 2005-57: B. Sportisse. Etat d'avancement de la convention cadre INERIS/CREA pour l'année 2005. 5 pages.
93. Rapport 2005-58: Denis Quélo, V. Mallet and B. Sportisse. Polyphemus Users' Guide. 27 pages.

94. Rapport 2005-59: E. Demael and B. Carissimo. A comparison between Eulerian CFD and Gaussian Plume models on Prairie Grass dispersion experiment. Preprint article submitted to Journal of Applied Meteorology. 40 pages.
95. Rapport 2005-60: M. Bocquet. Méthodes de l'assimilation de données I. Teaching notes ENSTA. 88 pages.
96. Rapport 2005-61: N. Rangod. Etude de la dispersion à petite échelle de polluants atmosphériques autour d'un chantier de rénovation urbaine. Rapport de stage ingénieur Ecole Centrale de Nantes.

## 2006

97. Rapport 2006-1: Rapport du Projet PAM. Rapport de contrat Primequal. B. Sportisse, K. Kata, E. Debry, K Fahey, Y. Roustan, M. Tombette, B. Albriet and H. Schmitt. 171 pages.
98. Rapport 2006-2: M. Tombette, L. Musson-Genon and B. Sportisse. Modélisation de l'impact du CPT de Porcheville. Résultats préliminaires. Rapport de contrat Mission Thermique EDF. 12 pages.
99. Rapport 2006-3: B. Sportisse. Le projet PAM. Actes Primequal. 4 pages.
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5. Vivien Mallet (6 décembre 2005) 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
6. Yelva Roustan (12 décembre 2005) Modélisation de la dispersion atmosphérique du mercure, du plomb et du cadmium à l'échelle européenne
7. Monika Krysta (14 septembre 2006) Modélisation inverse des radionucléides dans l'atmosphère
8. Maya Milliez (14 décembre 2006) Modélisation thermique au sein du modèle Mercure\_Saturne : Application à la modélisation de l'environnement urbain
9. Bastien Albriet (14 janvier 2007) Modélisation des aérosols à l'échelle locale et régionale
10. Emmanuel Demael (15 décembre 2007) Modélisation de la dispersion atmosphérique en milieu complexe et incertitudes associées
11. Marilyne Tombette (décembre 2007) Modélisation des aérosols à l'échelle régionale
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## **2.2 Publications de Christian Seigneur, Directeur du CEREA**

### **2.2.1 Articles dans des revues avec comité de lecture répertoriées dans les bases de données internationales (ACL)**

1. Seigneur, C., K. Vijayaraghavan, K. Lohman, P. Karamchandani, C. Scott, Global source attribution for mercury deposition in the United States, *Environ. Sci. Technol.*, **38**, 555-569 (2004).
2. Zhang, Y., B. Pun, K. Vijayaraghavan, S.-Y. Wu, C. Seigneur, S. Pandis, M. Jacobson, A. Nenes, J.H. Seinfeld, Development and application of the Model of Aerosol Dynamics, Reaction, Ionization and Dissolution, *J. Geophys. Res.*, **109**, D01202, doi:10.1029/2003JD003501 (2004).
3. Seigneur, C., K. Vijayaraghavan, K. Lohman, P. Karamchandani, Modeling the atmospheric fate and transport of mercury over North America: Power plant emission scenarios, *Fuel Processing Technol.*, **85**, 441-450 (2004).
4. Zhang, Y., B. Pun, S.-Y. Wu, K. Vijayaraghavan, C. Seigneur. Application and evaluation of two air quality models for PM for a southeastern U.S. episode, *J. Air Waste Manage. Assoc.*, **54**, 1478-1493 (2004).
5. Zhang, Y. K. Vijayaraghavan, C. Seigneur. Evaluation of three probing techniques in a three-dimensional air quality model, *J. Geophys. Res.*, **110**, D02305, doi:10.1029/2004JD005248. (2005).

6. Pun, B., C. Seigneur, K. Vijayaraghavan, S.-Y. Wu, S.-Y. Chen, E. Knipping, N. Kumar. Modeling regional haze in the BRAVO study using CMAQ-MADRID. 1. Model evaluation, *J. Geophys. Res.*, **111**, D06302, doi:10.1029/2004JD005608 (2006).
7. Knipping, E., N. Kumar, B.K. Pun, C. Seigneur, S.-Y. Wu, B.A. Schichtel. Modeling regional haze in the BRAVO study using CMAQ-MADRID. 2. Source-region attribution of particulate sulfate compounds, *J. Geophys. Res.*, **111**, D06303, doi:10.1029/2004JD005609 (2006).
8. Touma, J.S., V. Isakov, J. Ching, C. Seigneur. Air quality modeling of hazardous pollutants: current status and future directions, *J. Air Waste Manage. Assoc.*, **56**, 547-558 (2006).
9. Lohman, K., C. Seigneur, E. Edgerton, J. Jansen. Modeling mercury in power plant plumes, *Environ. Sci. Technol.*, **40**, 3848-3854 (2006).
10. Seigneur, C., K. Lohman, K. Vijayaraghavan, J. Jansen, L. Levin. Modeling atmospheric mercury deposition in the vicinity of power plants, *J. Air Waste Manage. Assoc.*, **56**, 743-751 (2006).
11. Zhang, Y., P. Liu, B. Pun, C. Seigneur. A comprehensive performance evaluation of MM5-CMAQ for the summer 1999 Southern Oxidants Study episode. Part I. Evaluation protocols, databases and meteorological predictions, *Atmos. Environ.*, **40**, 4825-4838 (2006).
12. Zhang, Y., P. Liu, A. Queen, C. Misenis, B. Pun, C. Seigneur, S.-Y. Wu. A comprehensive performance evaluation of MM5-CMAQ for the summer 1999 Southern Oxidants Study episode. Part II. Gas and aerosol predictions, *Atmos. Environ.*, **40**, 4839-4855 (2006).
13. Zhang, Y., P. Liu, B. Pun, C. Seigneur. A comprehensive performance evaluation of MM5-CMAQ for the summer 1999 Southern Oxidants Study episode. Part III. Diagnostic and mechanistic evaluations, *Atmos. Environ.*, **40**, 4856-4873 (2006).
14. Vijayaraghavan, K., P. Karamchandani, C. Seigneur. Plume-in-grid modeling of summer air pollution in central California, *Atmos. Environ.*, **40**, 5097-5109 (2006).
15. Pun, B., C. Seigneur, K. Lohman. Modeling secondary organic aerosol via multiphase partitioning with molecular data, *Environ. Sci. Technol.*, **40**, 4722-4731 (2006).
16. Karamchandani, P., K. Vijayaraghavan, S.-Y. Chen, C. Seigneur, E. Edgerton. Plume-in-grid modeling for particulate matter, *Atmos. Environ.*, **40**, 7280-7297 (2006).
17. Seigneur, C., K. Vijayaraghavan, K. Lohman. Atmospheric mercury chemistry: sensitivity of global model simulations to chemical reactions, *J. Geophys. Res.*, **111**, D22306, doi:10.1029/2005JD006 (2006).
18. Lindberg, S., O.R. Bullock, R. Ebinghaus, D. Engstrom, X. Feng, W. Fitzgerald, N. Pirrone, E. Prestbo, C. Seigneur. A synthesis of progress and uncertainties in attributing the sources of mercury in deposition, *Ambio*, **36**, 19-33 (2007).
19. Pun, B., C. Seigneur. Investigative modeling of new pathways for secondary organic aerosol formation, *Atmos. Chem. Phys.*, **7**, 2199-2216 (2007).
20. Bailey, E.M., L.L. Gautney, J.J. Kelsoe, M.E. Jacobs, J.W. Condrey, B. Pun, S.-Y. Wu, C. Seigneur, S. Douglas, J. Haney, N. Kumar. A comparison of the performance of four air quality models for the Southern Oxidants Study episode in July 1999, *J. Geophys. Res.*, **112**, D05306, doi:10.1029/2005JD007021 (2007).
21. Vijayaraghavan, K., C. Seigneur, P. Karamchandani, S.-Y. Chen. Development and application of a multi-pollutant model for atmospheric mercury deposition, *J. Appl. Meteorol. Climatol.*, **46**, 1341-1353 (2007).
22. Pun, B., C. Seigneur, E.M. Bailey, L.L. Gautney, S.G. Douglas, J.L. Haney, N. Kumar. Response of atmospheric particulate matter to changes in precursor emissions: A comparison of three air quality models, *Environ. Sci. Technol.*, **42**, 831-837 (2008).
23. Lohman, K., C. Seigneur, M. Gustin, S. Lindberg. Sensitivity of the global atmospheric cycling of mercury to emissions, *Appl. Geochem.*, **23**, 454-466 (2008).
24. Vijayaraghavan, K., H.E. Snell, C. Seigneur. Practical aspects of using satellite data in air quality modeling, *Environ. Sci. Technol.*, **42**, sous presse (2008).
25. Bullock, O.R., Jr., D. Atkinson, T. Braverman, K. Civerolo, A. Dastoor, D. Davignon, J.-Y. Ku, K.

- Lohman, T. Myers, R. Park, C. Seigneur, N.E. Selin, G. Sistla, K. Vijayaraghavan. The North American Mercury Model Intercomparison Study (NAMMIS). Study description and model-to-model comparisons, *J. Geophys. Res.*, doi:10.1029/2008JD009803, sous presse.
26. Seigneur, C. Current understanding of ultra fine particulate matter emitted from mobile sources, *J. Air Waste Manage. Assoc.*, sous presse.
  27. Pun, B., C. Seigneur. Organic aerosol spatial/temporal patterns: Perspective of measurements and model, *Environ. Sci. Technol.*, sous presse.
  28. Karamchandani, P., K. Lohman, C. Seigneur. Using a sub-grid scale modeling approach to simulate the transport and fate of toxic air pollutants, *Environ. Fluid Mechanics*, sous presse.
  29. Pun, B., R. Balmori, C. Seigneur. Modeling wintertime particulate matter formation in central California, *Atmos. Environ.*, sous presse.
  30. Vijayaraghavan, K., P. Karamchandani, C. Seigneur, R. Balmori, S.-Y. Chen. Plume-in-grid modeling for atmospheric mercury, *J. Geophys. Res.*, sous presse.
  31. Seigneur, C., K. Lohman. Effect of bromine chemistry on the atmospheric mercury cycle, *J. Geophys. Res.*, sous presse.

## **2.2.2 Articles dans des revues sans comité de lecture (ASCL)**

1. Knipping, E., R.J. Griffin, F.M. Bowman, B. Pun, C. Seigneur, D. Dabdub, J.H. Seinfeld. Comment on “Instantaneous secondary organic aerosol yields and their comparison with overall aerosol yields for aromatic and biogenic hydrocarbons” by Weimin Jiang, *Atmos. Environ.*, **38**, 2759-2761 (2004).
2. Seigneur, C. Air pollution: current challenges and future opportunities, *Amer. Inst. Chem. Eng. J.*, **51**, 355-363 (2005); réimprimé dans *Pollution Atmosphérique*, **186**, 187-199 (2005).

## **2.2.3 Communications (ACT, COM & AFF)**

1. Vijayaraghavan, K., C. Seigneur, K. Lohman, P. Karamchadani, L. Levin and J. Jansen, Modeling the impact of mercury speciation in power plant plumes on mercury deposition over the eastern U.S., 7<sup>th</sup> Electric Utilities Environmental Conference – Air Quality, Global Climate Change and Renewable Energy, 19-22 January 2004, Tucson, Arizona.
2. Levin, L., R. Carlton, C. Whipple, H. Friedli and C. Seigneur, New findings on mercury dynamics, 7<sup>th</sup> Electric Utilities Environmental Conference – Air Quality, Global Climate Change and Renewable Energy, 19-22 January 2004, Tucson, Arizona.
3. Knipping, E., N. Kumar, B. Pun, S.-Y. Wu, and C. Seigneur, Source-region attribution of sulfate at Big Bend National Park using CMAQ-MADRID, 7<sup>th</sup> Electric Utilities Environmental Conference – Air Quality, Global Climate Change and Renewable Energy, 19-22 January 2004, Tucson, Arizona.
4. Seigneur, C., Model evaluation – comparing model output to ambient data, PM Model Performance Workshop, 10 February 2004, Chapel Hill, North Carolina.
5. Pun, B.K., S.-Y. Chen, K. Lohman and C. Seigneur. Model performance evaluation data base and software – application to CENRAP, PM Model Performance Workshop, 10-12 February 2004, Chapel Hill, North Carolina.
6. Seigneur, C. Three-dimensional modeling of particulate matter – Current performance & future prospects, EMEP Workshop on Particulate Matter Measurement & Modeling, 20-23 April 2004, New Orleans, Louisiana.
7. Pun.B., Y. Zhang, K. Vijayaraghavan, S.-Y. Wu and C. Seigneur, New PM<sub>2.5</sub> modeling techniques, Looking Forward on Air Quality and Air Toxics Issues - Annual Meeting of the West Coast Section – Air & Waste Management Association, 13 May 2004, Ventura, California.
8. Zhang, Y. K. Vijayaraghavan, C. Seigneur and G. Tonnesen. Evaluation of probing tools for air quality models, 97th Air and Waste Management Association Annual Meeting, June 22-25, 2004,

Indianapolis, Indiana.

9. Vijayaraghavan, K., K. Lohman, S.-Y. Chen, P. Karamchandani, C. Seigneur, A. Smith, J. Jansen and L. Levin, Sensitivity of mercury atmospheric deposition to anthropogenic emissions in the United States, 7<sup>th</sup> International Conference on Mercury as a Global Pollutant, 27 June – 2 July 2004, Ljubljana, Slovenia; RMZ – Materials and Geoenvironment (formerly Rudarsko-metalurski zbornik (Mining and Metallurgy Quarterly)), Vol. 51, pp. 1817-1820 (2004).
10. Seigneur, C., K. Lohman, K. Vijayaraghavan, J. Jansen and L. Levin, Comparison of grid-based and plume modeling to estimate the local impacts of large mercury point sources, 7<sup>th</sup> International Conference on Mercury as a Global Pollutant, 27 June – 2 July 2004, Ljubljana, Slovenia; RMZ – Materials and Geoenvironment (formerly Rudarsko-metalurski zbornik (Mining and Metallurgy Quarterly)), Vol. 51, pp. 1749-1752 (2004).
11. Lohman, K., C. Seigneur and J. Jansen, Modeling mercury transformation in power plant plumes, 7<sup>th</sup> International Conference on Mercury as a Global Pollutant, 27 June – 2 July 2004, Ljubljana, Slovenia; RMZ – Materials and Geoenvironment (formerly Rudarsko-metalurski zbornik (Mining and Metallurgy Quarterly)), Vol. 51, pp. 1658-1661 (2004).
12. Ryaboshapko, A., R. Artz, R. Bullock, J. Christensen, M. Cohen, A. Dastoor, D. Davignon, R. Draxler, R. Ebinghaus, I. Ilyin, D. Lee, J. Munthe, J. Pacyna, G. Petersen, C. Seigneur, D. Syrakov and O. Tranikov, Performance of atmospheric long-range transport models for mercury species: Results from a model intercomparison study, 7<sup>th</sup> International Conference on Mercury as a Global Pollutant, 27 June – 2 July 2004, Ljubljana, Slovenia; RMZ – Materials and Geoenvironment (formerly Rudarsko-metalurski zbornik (Mining and Metallurgy Quarterly)), Vol. 51, pp. 1739-1743 (2004).
13. Bailey, E.H., L. Gautney, M. Jacobs, J. Lescoe, B. Pun, C. Seigneur, S. Douglas, J. Haney and N. Kumar, A comparison of model Performance of CMAQ, MADRID 1, MADRID 2 and REMSAD, 23<sup>rd</sup> Annual American Association for Aerosol Research Conference, 4-8 October 2004, Atlanta, GA, U.S.A.
14. Pun,B., C. Seigneur, E.H. Bailey, L. Gautney, M. Jacobs, J. Lescoe, S. Douglas, J. Haney and N. Kumar, Comparing the response of CMAQ, MADRID 1, MADRID 2 and REMSAD to changes in precursor emissions, 23<sup>rd</sup> Annual American Association for Aerosol Research Conference, 4-8 October 2004, Atlanta, GA, U.S.A.
15. Zhang, Y., J. Bulau, B. Pun, C. Seigneur and M. Jacobson, 3-D model evaluation: Aerosol mass and number size distributions, 23<sup>rd</sup> Annual American Association for Aerosol Research Conference, 4-8 October 2004, Atlanta, GA, U.S.A.
16. Zhang, Y., P. Liu, C. Misenis, A. Queen, B. Pun, and C. Seigneur, Performance evaluation of CMAQ for summer 1999 Southern Oxidants Study episode, 2004 Models-3 User's Workshop, 18-20 October 2004, Chapel Hill, North Carolina.
17. Seigneur, C., B. Pun, P. Karamchandani, K. Vijayaraghavan, S.-Y. Chen, E. Knipping and N. Kumar, A new version of CMAQ-MADRID and comparison with CMAQ, 2004 Models-3 User's Workshop, 18-20 October 2004, Chapel Hill, North Carolina.
18. Vijayaraghavan, K., P. Karamchandani and C. Seigneur, Evaluation of an advanced plume-in-grid treatment in CMAQ with data from the Central California Ozone Study, 2004 Models-3 User's Workshop, 18-20 October 2004, Chapel Hill, North Carolina.
19. Seigneur, C., K. Vijayaraghavan, K. Lohman and P. Karamchandani, Mercury source attribution at global, regional and local scales, 2<sup>nd</sup> Intercontinental Transport and Climatic Effects of Air Pollutants (ICAP) Workshop, 21-22 October, 2004, Chapel Hill, North Carolina.
20. Pun, B.K., C. Seigneur and E. Knipping, Optimizing secondary organic aerosol representation in particulate matter air quality models, Air & Waste Management Association Visibility Specialty Conference – Regional and Global Perspectives on Haze: Causes, Consequences and Controversies, 26-29 October 2004, Asheville, North Carolina.
21. Karamchandani, P., C. Seigneur and K. Vijayaraghavan, Development and testing o an advanced

- plume-in-grid PM model, Air & Waste Management Association Visibility Specialty Conference – Regional and Global Perspectives on Haze: Causes, Consequences and Controversies, 26-29 October 2004, Asheville, North Carolina.
22. Seigneur, C., Air toxics modeling: state of the science, current challenges and future prospects, Coordinating Research Council (CRC) Mobile Source Air Toxics Workshop, 1-2 December 2004, Scottsdale, Arizona.
  23. Levin, L., A. Smith, C. Seigneur and C. Whipple, Integrative analysis of U.S. mercury sources and deposition, 7<sup>th</sup> Electric Utilities Environmental Conference – Air Quality, Global Climate and Renewable Energy, 24-26 January 2005, Tucson, Arizona.
  24. Vijayaraghavan, K., K. Lohman, S.-Y. Che, C. Seigneur, A. Smith, L. Levin and J. Jansen, Modeling of mercury emission control scenarios for coal-fired power plants, 8<sup>th</sup> Electric Utilities Environmental Conference – Air Quality, Global Climate and Renewable Energy, 24-26 January 2005, Tucson, Arizona.
  25. Whipple, C., C. Seigneur, A. Smith and L. Levin, Mercury exposure across the United States under regulatory scenarios, 8<sup>th</sup> Electric Utilities Environmental Conference – Air Quality, Global Climate and Renewable Energy, 24-26 January 2005, Tucson, Arizona.
  26. Pun, B. and C. Seigneur, Relationship between ozone and PM during CRPAQS, American Association for Aerosol Research Supersites Conference, 7-9 February 2005, Atlanta, Georgia.
  27. Pun, B., C. Seigneur, S.-Y. Chen and M. Sze, Creation of an air quality database for health effects studies, Health Effects Institute Annual Conference, 17-19 April 2005, Baltimore, Maryland.
  28. Vijayaraghavan, K., C. Seigneur, K. Lohman, S-Y. Chen, P. Karamchandani, Modeling of atmospheric mercury deposition in the Great Lakes region, International Association for Great Lakes Research 47th Annual Conference, 23-27 May 2005, Ann Arbor, Michigan.
  29. Seigneur, C., K. Vijayargahvan, K. Lohman and L. Levin, Effect of atmospheric chemistry on mercury deposition in the United States, Air Quality V: International conference on Mercury, Trace Elements, SO<sub>3</sub> and Particulate Matter, 19-21 September 2005, Arlington, Virginia.
  30. Karamchandani, P., K. Vijayargahavan, S.-Y. Chen and C. Seigneur, Development and application of two advanced plume-in-grid PM models, CMAQ-PM-APT and CMAQ-MADRID-APT, Fourth Annual CMAS Models-3 User's Conference, 26-28 September 2005, Chapel Hill, North Carolina.
  31. Vijayaraghavan, K., P. Karamchandani, S.-Y. Chen and C. Seigneur, Development and application of CMAQ-MADRID-Mercury, Fourth Annual CMAS Models-3 User's Conference, 26-28 September 2005, Chapel Hill, North Carolina.
  32. Pun, B., K. Lohman, S.-Y. Wu, S.-Y. Chen and C. Seigneur, Model performance evaluation software: description and application to regional haze modeling, Fourth Annual CMAS Models-3 User's Conference, 26-28 September 2005, Chapel Hill, North Carolina.
  33. Seigneur, C., Status of PM air quality modeling, Fourth Annual CMAS Models-3 User's Conference, 26-28 September 2005, Chapel Hill, North Carolina.
  34. Pun, B., K. Lohman and C. Seigneur, Weekday/weekend differences of toxics air pollutants in Houston, New York and Philadelphia, Air Toxics Monitoring Data Analysis Workshop, 27-28 September 2005, Research Triangle Park, North Carolina.
  35. Vijayaraghavan, K., C. Seigneur, P. Karamchandani, K. Lohman and S.-Y. Chen, Modeling of atmospheric mercury deposition in the United States, National Atmospheric Deposition Program Technical Meeting, 28-29 September 2005, Jackson Hole, Wyoming.
  36. Pun, B.K., C. Seigneur, J. Pankow, R. Griffin and E. Knipping, An upgraded absorptive secondary organic aerosol partitioning module for three-dimensional air quality applications, 24<sup>th</sup> Annual American Association for Aerosol Research Conference, 17-21 October 2005, Austin, Texas.
  37. Pun, B., K. Lohman and C. Seigneur, Modeling the formation of hydrophilic and hydrophobic secondary organic aerosols from anthropogenic and biogenic precursors, 24<sup>th</sup> Annual American Association for Aerosol Research Conference, 17-21 October 2005, Austin, Texas.
  38. Vijayaraghavan, K., P. Karamchandani, K. Lohman, C. Seigneur and L. Levin, Modeling of

- atmospheric mercury deposition over North America using CMAQ-MADRID-Hg, 9<sup>th</sup> Electric Utilities Environmental Conference – Clean air, Mercury, Global Warming and Renewable Energy, 23-25 January 2006, Tucson, Arizona.
39. Pun, B., C. Seigneur, S.-Y. Chen and M. Sze, Web-based database for particulate matter health effects studies, 2006 Health Effects Institute Annual Conference, 9-11 April 2006, San Francisco, California.
  40. Bullock, R., D. Atkinson, T. Braverman, A. Dastoor, D. Davignon, N. Eckley-Selin, D. Jacob, K. Lhoman, C. Seigneur, K. Vijayaraghavan and T. Myers, The North American Mercury Model Inter-comparison Study (NAMMIS), 28<sup>th</sup> International Technical Meeting on Air Pollution Modeling and Its Application, 15-19 May 2006, Leipzig, Germany.
  41. Lindberg, S., O.R. Bullock, R. Ebinghaus, D. Engstrom, X. Feng, W. Fitzgerald, N. Pirrone, E. Prestbo and C. Seigneur, Source attribution of atmospheric mercury deposition, 8<sup>th</sup> International Conference on Mercury as a Global Pollutant, 6-11 August 2006, Madison, WI, USA.
  42. Bullock, O.R., K. Lohman, C. Seigneur, K. Vijayaraghavan, A. Dastoor, D. Davignon, N. Eckley-Selin, D. Jacob, T. Myers, K. Civerolo, C. Hogrefe, J.-Y. Ku, G. Sistla, D. Atkinson and T. Braverman, Results from the North American Mercury Model Inter-comparison Study (NAMMIS), 8<sup>th</sup> International Conference on Mercury as a Global Pollutant, 6-11 August 2006, Madison, WI, USA.
  43. Seigneur, C., K. Lohman, M. Gustin and S. Lindberg, Sensitivity of the global atmospheric cycling of mercury to emissions, 8<sup>th</sup> International Conference on Mercury as a Global Pollutant, 6-11 August 2006, Madison, WI, USA.
  44. Karamchandani, P., K. Vijayaraghavan and C. Seigneur, Detailed treatment of power plant plumes in the regional modeling of atmospheric mercury, 8<sup>th</sup> International Conference on Mercury as a Global Pollutant, 6-11 August 2006, Madison, WI, USA.
  45. Vijayaraghavan, K., C. Seigneur, P. Karamchandani and S.-Y. Chen, Comparison of atmospheric sulfate and mercury deposition in the United States: measurements and simulations, 8<sup>th</sup> International Conference on Mercury as a Global Pollutant, 6-11 August 2006, Madison, WI, USA.
  46. Karamchandani, P., K. Vijayaraghavan, S.-Y. Chen and C. Seigneur, Plume-in-grid modeling for PM and mercury, Fifth Annual CMAS Conference, 16-18 October 2006, Chapel Hill, North Carolina.
  47. Pun, B. and C. Seigneur, Using CMAQ to interpolate among CASTNET measurements, Fifth Annual CMAS Conference, 16-18 October 2006, Chapel Hill, North Carolina.
  48. Pun, B., S.-Y. Chen and C. Seigneur, 2006 Coordinating Research Council Mobile Source Air Toxics Workshop, Using ambient data and air quality modeling to investigate weekday/weekend temporal profiles for mobile source air toxics, 23-25 October 2006, Phoenix, Arizona.
  49. Vijayaraghavan, K., P. Karamchandani, R. Balmori and C. Seigneur, Modeling of atmospheric deposition of mercury, sulfate, ammonium, and nitrate and comparison with NADP measurements, National Acid Deposition Program Technical Meeting, 25-26 October 2006, Norfolk, Virginia.
  50. Seigneur, C. and B. Pun, Modélisation des aérosols organiques secondaires : Etat de la science et futures directions, 22ème congrès français sur les aérosols, CFA 2006, 29-30 November 2006, Paris, France.
  51. Seigneur, C., Particulate matter modeling: Scientific issues and future prospects, Convention on Long-range Transboundary Air Pollution, Task Force on Modeling & Monitoring Workshop on the EMEP PM Assessment Report, 29 November – 1 December 2006, Paris, France.
  52. Pun, B., C. Seigneur, S.-Y. Chen and M. Sze, The HEI air quality database, Health Effects Institute Workshop on Air Quality Data in Health Effects Research, 30 November – 1 December 2006, Newton, Massachusetts.
  53. Vijayaraghavan, K., P. Karamchandani, S.-Y. Chen, R. Balmori, C. Seigneur, L. Levin, E. Knipping and J. Jansen, Plume-in-grid modeling of particulate matter over North America, Electric Utility Environmental Conference, 22-24 January 2007, Tucson, Arizona.
  54. Levin, L., C. Seigneur, K. Vijayaraghavan and A. Smith, Mercury deposition beyond CAMR: Case studies, Electric Utility Environmental Conference, 22-24 January 2007, Tucson, Arizona.

55. Pun, B., C. Seigneur, S.-Y. Chen and M. Sze, Web-based database for particulate matter health effects studies, Health Effects Institute 2007 Annual Conference, 15-17 April 2007, Chicago, Illinois.
56. Seigneur, C., Air quality models for health and environmental management: Inputs for human exposure and deposition to ecosystems, NARSTO Meeting on Multi-Pollutant Air Quality Assessment, 18 July 2007, Denver, Colorado.
57. Seigneur, C. Evaluating the performance of chemical and aerosol processes within air quality models, Workshop on the Evaluation of Regional-Scale Air Quality Modeling Systems, 7-8 August 2007, Research Triangle Park, North Carolina.
58. Walters, J., K. Vijayaraghavan, J. Haney, R. Balmori, S.-Y. Chen, S.G. Douglas, T.C. Myers, J.J. Jansen, E.M. Knipping and C. Seigneur, Model assessment of atmospheric nitrogen deposition response to EGU pollution controls for the Escambia Bay, Florida watershed, National Atmospheric Deposition Program Annual Meeting and Scientific Symposium, 10-12 September 2005, Boulder, Colorado.
59. Vijayaraghavan, K., P. Karamchandani, R. Balmori, C. Seigneur, L. Levin and J.J. Jansen, Plume-in-grid modeling of atmospheric mercury deposition in the United States, National Atmospheric Deposition Program Annual Meeting and Scientific Symposium, 10-12 September 2005, Boulder, Colorado.
60. Vijayaraghavan, K., C. Seigneur, P. Karamchandani, S.-Y. Chen, R. Balmori and J. Jansen, Multi-pollutant plume-in-grid modeling over the southeastern United States, Air Quality VI: International conference on Mercury, Trace Elements, SO<sub>3</sub> and Particulate Matter, and Greenhouse Gases, 24-27 September 2007, Arlington, Virginia.
61. Seigneur, C., K. Lohman, K. Vijayaraghavan, R. Balmori and L. Levin, Effect of bromine chemistry on mercury deposition in the United States, Air Quality VI: International conference on Mercury, Trace Elements, SO<sub>3</sub> and Particulate Matter, and Greenhouse Gases, 24-27 September 2007, Arlington, Virginia.
62. Debry, E. and C. Seigneur, Tracking organic particulate matter in Europe with the SIREAM/AEC aerosol model: comparisons to measured data and sensitivity to model parameters, 26<sup>th</sup> Annual American Association for Aerosol Research Conference, 24-28 September 2007, Reno, Nevada.
63. Pun, B., R. Balmori and C. Seigneur, Modeling a wintertime PM<sub>2.5</sub> episode in the California Central Valley, 26<sup>th</sup> Annual American Association for Aerosol Research Conference, 24-28 September 2007, Reno, Nevada.
64. Karamchandani, P., K. Lohman and C. Seigneur, Sub-grid scale modeling of air toxics concentrations near roadways, Sixth Annual CMAS Conference, 1-3 October 2007, Chapel Hill, North Carolina.
65. Vijayaraghavan, K., R.T. Balmori, S.-Y. Chen, P. Karamchandani and C. Seigneur, Modeling of atmospheric nitrogen deposition to the Escambia Bay and watershed in the southeastern United States, Sixth Annual CMAS Conference, 1-3 October 2007, Chapel Hill, North Carolina.
66. Karamchandani, P., K. Vijayaraghavan, S.-Y. Chen, C. Seigneur and E. Knipping, Plume-in-grid modeling for PM: A parallel approach, International Aerosol Modeling Algorithms Conference, 5-7 December 2007, Davis, California.
67. Debry, E., C. Seigneur and K. Sartelet, Organic aerosols in the air quality platform Polyphemus: Oxidation pathways, hydrophilic/hydrophobic partitioning and oligomerization, International Aerosol Modeling Algorithms Conference, 5-7 December 2007, Davis, California.
68. Bessagnet, B., C. Seigneur, B. Pun, L. Menut, A. Hodzic, S. Moukhtar, B. Guillaume and C. Liousse, Modeling of carbonaceous aerosols within CHIMERE: Focus on secondary organic aerosols, International Aerosol Modeling Algorithms Conference, 5-7 December 2007, Davis, California.
69. Pun, B. and C. Seigneur, Variation spatio-temporelle des aerosols organiques secondaires : comparaison de mesures et de simulations, 23ème congrès français sur les aérosols, CFA 2006, 16-17 January 2008, Paris, France.
70. Seigneur, C., K. Vijayaraghavan, K. Lohman and L. Levin. The AER/EPRI global chemical

- transport model for mercury (CTM-Hg), Joint International Conference of the UNEP Global Partnership on Atmospheric Mercury Transport and Fate Research & Task Force on Hemispheric Transport of Air Pollution of the UNECE-LRTAP Convention, 7-11 April 2008, Rome, Italy.
71. Pun, B., C. Seigneur and S.-Y. Chen. Web-accessible relational database for the relationship of indoor, outdoor, and personal air (RIOPA) study, Health Effects Institute 2008 Annual Conference, 27-29 April 2008, Philadelphia, Pennsylvania.

#### **2.2.4 Ouvrages scientifiques (OS)**

1. Seigneur, C., M. Moran. Chapitre 8: Chemical transport models, *in* Particulate Matter Science for Policy Makers: A NARSTO Assessment, pp. 283-323, P.H. McMurry, M. Shepherd, J. Vickery, eds., Cambridge University Press, Cambridge, Royaume Uni (2004).
2. George, C., B. Aumont, B. Bessagnet, M. Rossi, M. Schwell, C. Seigneur, E. Villenave. Chapitre 4 : Physico-chimie et transport, *in* Pollution par les particules atmosphériques : état des connaissances et perspectives de recherche, pp. 131-161, P. Ebner, Y. Le Moullec et A. Weill, eds., La Documentation Française, Paris (2005).
3. Pun, B., C. Seigneur, H. Michelsen. Chapitre 12: Atmospheric Transformations, *in* Air Quality Modeling - Theories, Methodologies, Computational Techniques, and Available Databases and Software, Vol. II – Advanced Topics, 163-266, P. Zannetti, ed., Air & Waste Management Association (2005).

### **3. Enseignement et formation par la recherche, information et culture scientifique et technique**

La formation par la recherche est particulièrement importante au CEREA puisqu'il y a en moyenne une dizaine d'étudiants en thèse de doctorat. Tous les doctorants du CEREA sont encadrés par un ou plusieurs chercheurs permanents du CEREA. Certains thésards ont obtenu des prix à des congrès ou ont été nominés pour le Prix de thèse ENPC (voir chapitre 1.1.2). Par ailleurs, le CEREA accueille chaque été plusieurs stagiaires sur les sites de l'ENPC (y compris des élèves du Corps des ponts et chaussées) et de l'INRIA ; il y a eu sept stagiaires en 2008).

Les membres du CEREA joue un rôle important dans l'enseignement des sciences atmosphériques et de la modélisation mathématique. Le tableau suivant donne un aperçu des cours enseignés au cours des quatre dernières années.

La diffusion de l'information se fait bien sûr à travers les publications dans les revues scientifiques et les communications à des congrès et colloques (voir chapitre 2). Par ailleurs, des brochures sur des sujets précis sont parfois publiés afin d'attirer l'attention de la communauté scientifique sur les travaux du CEREA dans un domaine déterminé (par exemple, voir les Dossiers Recherche de l'Ecole des ponts N° 6 ( « Mercure\_Saturne : Un outil de modélisation atmosphérique à l'échelle locale » par le groupe EDF R&D du CEREA) et N° 17 ( « Comment prévoir la dispersion d'un panache de polluant de source mal connue en cas d'accident nucléaire ou industriel » par Marc Bocquet).

Une série de séminaires est organisée chaque année afin d'offrir aux membres du CEREA des informations sur des sujets scientifiques et techniques qui se rapportent aux activités du CEREA mais peuvent aussi toucher à des sujets légèrement différents. Une liste des séminaires donnés par des intervenants extérieurs pendant l'année académique 2007-2008 est fournie ci-dessous.

Tableau 3. Liste des cours donnés par les membres du CREA pendant la période 2004-2008.

Cours	Lieu d'enseignement	Programme	Enseignants du CREA	Nombre d'heures par an
Pollution atmosphérique	Ecole des Ponts ParisTech	Cycle ingénieur civil et corps des ponts	Bruno Sportisse	42 heures
Mathématiques appliquées*	Ecole des Ponts ParisTech	Cycle ingénieur civil et corps des ponts	Bruno Sportisse	30 heures
Mécanique des fluides	Ecole des Ponts ParisTech	Cycle ingénieur civil et corps des ponts	Bertrand Carissimo	30 heures
Pollution atmosphérique et transports	Ecole des Ponts ParisTech	Master Transport et Développement Durable (TRADD)	Stéphanie Lacour, Bruno Sportisse, K. Sartelet	30 heures
Assimilation de données et modélisation inverse	ENSTA ParisTech	Master 2	Marc Bocquet, Vivien Mallet et Bruno Sportisse	29 heures
Calcul scientifique pour l'environnement*	ENSTA ParisTech	Master 1	Bruno Sportisse et Vivien Mallet	25 heures
Modélisation de l'atmosphère	Université Paris Diderot (Paris VII)	Master Sciences et Génie de l'Environnement, Option Atmosphère et Qualité de l'Air	Bertrand Carissimo, Edouard Debry, Vivien Mallet	11 heures
Environnement atmosphérique*	Ecole centrale de Marseille	Cycle ingénieur	Bertrand Carissimo et Luc Musson-Genon	24 heures
Algorithmique	Ecole supérieure d'ingénieurs Léonard de Vinci	Master 1	Isabelle Herlin et Jean-Paul Berroir	35 heures
Algorithmique*	ESIEE Management	Cycle ingénieur, license	Isabelle Herlin	30 heures
Multimédia*	ESIEE Management	Cycle ingénieur, license	Isabelle Herlin	21 heures
Traitement et analyse d'images*	Université Paris VI	Master 2	Dominique Béréziat	40 heures
Pollution atmosphérique	Ecole nationale des travaux publics de l'état	Cycle ingénieur	Stéphanie Lacour, Yelva Roustan	20 heures

\* Cours qui n'est plus donné par des membres du CREA en 2008-2009.

Tableau 4. Séminaires donnés au CEREA pendant l'année académique 2007-2008

Date	Titre	Intervenant
11 Octobre 2007	Caractérisation du transport intercontinental des polluants	Elsa Real (Laboratoire d'aérologie - Université Paris VI)
22 Octobre 2007	Etude de l'impact radiatif direct de l'aérosol par mesures expérimentales et modélisation numérique durant les campagnes ESCOMPTE 2001 et AMMA/SOP_0	Marc Mallet (Laboratoire d'aérologie - Université Paris VI)
3 Mars 2008	Arbitrary Moment Internally-Mixed Aerosol Dynamic Equation	Professeur Anthony Wexler (University of California at Davis)
26 Mars 2008	GeoStockage du Co2 et surveillance de l'environnement	Guillemette Picard (Schlumberger)
7 Avril 2008	An overview of the air quality and emergency modelling system SILAM by	Mikhail Sofiev (Finnish Meteorological Institute)
7 Avril 2008	Data assimilation for air quality analysis and forecasting by	Julius Vera (Finnish Meteorological Institute)
5 Mai 2008	Role of shallow cumulus on atmospheric boundary layer chemistry	Jordi Vila Guerau (Pays Bas)

## **4. Actions de formation permanente**

Le CEREA étant un laboratoire commun ENPC- EDF R&D intégrant une équipe commune (CLIME) avec l'INRIA et à ce titre tri-localisé, dispose de personnels issus de ces trois entités. Le CEREA n'ayant pas de personnalité juridique propre, la formation permanente et le déroulement de carrière dépendent de ces différents organismes de tutelle. Il en est de même pour l'hygiène et la sécurité et les aspects éthiques qui sont présentés dans les chapitres suivants.

Les chercheurs du CEREA peuvent effectuer divers stages ou suivre des cours afin d'améliorer leurs connaissances dans divers domaines. Par exemple, certains chercheurs ENPC du CEREA ont suivis des cours d'anglais et des cours d'informatiques (programmation en langage Python). Des formations techniques associées à des congrès ou colloques sont aussi suivies par certains chercheurs.

Chaque agent EDF du CEREA négocie avec sa hiérarchie un plan individuel de formation au cours de son entretien annuel d'évaluation. Les formations suivies ces quatre dernières années concernent : la formation en langue anglaise (1), la formation informatique (stages Python (6), SIMAIL outil de maillage en mécanique des fluides (4), la bureautique (2), le management (1), la sensibilisation aux risques routiers (4). Par ailleurs un compte formation permanente est attribué à chaque agent et crédité de 20 heures/an.

A l'INRIA, la Commission Locale de Formation Permanente (CLFP) a pour missions de mener une réflexion prospective en matière de formation à partir des disciplines et des métiers et de participer à l'élaboration du plan annuel de formation du centre de recherche, en analysant les demandes des personnels. Sous la présidence du directeur du centre, elle se réunit au moins trois fois par an pour faire le bilan de l'année écoulée et construire le plan de l'année à venir, pour préparer la Commission Nationale de Formation Permanente et pour analyser le déroulement du plan à mi-année. Les priorités des offres de formation ont porté sur :

- l'anglais, pour accompagner l'ouverture à l'international et le français langue étrangère pour aider à l'intégration,
- la professionnalisation des métiers supports,
- la promotion des formations ciblées sur les projets scientifiques,
- l'accompagnement des projets professionnels personnels (bilans de compétences, validation des acquis de l'expérience,...),
- le développement de la culture et des pratiques de management,
- les formations pour apprendre à mieux utiliser les outils et l'environnement informatique.

Les membres du CEREA n'ont pas jusqu'à présent dispensé d'enseignement dans le cadre de la formation permanente.

## 5. Hygiène et sécurité

L'hygiène et la sécurité sont gérées au CEREA selon les organisations hôtes des trois sites du laboratoire.

A l'ENPC, l'hygiène et la sécurité sont régies selon l'article 18 du règlement intérieur de l'Ecole. Aucun accident du travail n'a été reporté depuis 2004.

A EDF, conformément à la législation du travail, le Comité Hygiène et Sécurité et Conditions de Travail (CHSCT) se réunit quatre fois par an pour le site EDF R&D de Chatou qui accueille le CEREA. En terme d'accident de travail, on peut signaler un accident de trajet en deux roues (bicyclette) ayant entraîné un arrêt de travail de 5 mois d'un membre du CEREA. Devant la recrudescence de ce type d'accident de trajet, un stage de sensibilité à la sécurité routière, spécifique « deux roues » sera organisé au niveau de la R&D d'EDF. Par ailleurs, chaque nouvel arrivant travaillant dans les locaux du CEREA à EDF Chatou suit un stage d'une demi-journée de sensibilisation à la sécurité, formation prévue dans le cadre du plan de prévention du département MFEE (Mécanique des Fluides, Energétique et Environnement) d'EDF R&D auquel est rattaché le personnel EDF du CEREA.

Enfin en raison des risques inhérents à l'activité de mesures atmosphériques à l'extérieur, chaque déploiement d'un dispositif expérimental sur site naturel (hors EDF) fait l'objet d'un plan particulier de prévention. Ceci a été réalisé pour la campagne sur le potentiel Eolien aux Avants-Monts dans le sud de la France et bien sûr pour notre plate-forme expérimentale au SIRTA située sur le site de l'Ecole Polytechnique à Palaiseau. Ceci est d'ailleurs explicitement mentionné dans les contrats 2006-2008 et 2008-2011 (en cours de signature) définissant la collaboration autour de l'activité instrumentale du SIRTA. Au titre de cette convention une révision du plan de prévention est prévue sur un rythme annuel.

A l'INRIA, le comité local hygiène et sécurité (CLHS) traite de tous les problèmes relatifs à l'hygiène et à la sécurité sur le site. Il a pour mission de contribuer à la protection de la santé et à la sécurité des personnels sur leur lieu de travail. Il est présidé par le directeur de centre et est composé de 5 représentants de l'administration et de 7 représentants du personnel désignés par les organisations syndicales représentatives. Le médecin de prévention et l'ACMO (agent chargé de la mise en œuvre des règles d'hygiène et de sécurité) assistent à chaque séance, avec voix consultative. Chaque séance du comité, qui se réunit 2 ou 3 fois par an, donne lieu à la rédaction d'un procès-verbal et à un suivi des décisions. Des bilans de l'activité du CLHS et des accidents de service sont présentés chaque année. Le CLHS étudie également le rapport annuel d'activité du médecin de prévention. De plus, deux registres sont à la disposition du personnel :

- Un registre destiné à recueillir les observations des agents, et le cas échéant, des usagers du site de Rocquencourt, relatives à la prévention des risques professionnels et à l'amélioration des conditions de travail. Ce registre est régulièrement consulté et visé par l'ACMO de Rocquencourt. Les mesures éventuelles sont prises. Il est examiné à chaque réunion du CLHS.
- Un registre spécial destiné au signalement d'un danger grave et imminent, par un membre du CLHS ou un agent. Chaque déclaration est immédiatement communiquée au service concerné et au directeur du centre de recherche. Les mesures prises y sont consignées.

## **6. Ethique**

Les règles générales d'éthique scientifique pour la recherche et la publication de travaux de recherche sont bien sûr suivies par les chercheurs du CEREA. Par ailleurs, comme tout agent d'EDF, les membres du CEREA EDF sont concernés par la Charte d'Ethique rédigée au niveau de l'entreprise EDF.

## ACRONYMS - ABBREVIATIONS

ADEME	Agence de l'Environnement et de la Maîtrise de l'Energie
ANR	Agence Nationale de la Recherche
CASU	Cellule d'Appui aux Situations d'urgence (Emergency Center at INERIS)
CEA	Commissariat à l'Energie Atomique
CEREA	Centre d'Enseignement et de Recherche en Environnement Atmosphérique
CETE	Centre d'Etudes Techniques de l'Equipement
CETU	Centre d'Etudes des Tunnels
CFD	Computational Fluid Dynamics
CIDEN	Centre d'Ingénierie, Déconstruction et Environnement (EDF)
CRIEPI	Central Research Institute for Electric Power Industry (Japon)
CSTB	Centre Scientifique et Technique du Bâtiment
CTM	Chemistry Transport Models
DGA	Délégation Générale pour l'Armement
DRAST	Direction de la Recherche et des Affaires Scientifiques et Techniques du MTETM
DTEP	Délégation Technique Environnement Patrimoine (EDF)
ECL	Ecole Centrale de Lyon
EDF R&D	Electricité de France Recherche et Développement
EMS-Beijing	Ensemble forecasting modeling system for Beijing
ENPC	Ecole Nationale des Ponts et Chaussées
ENSTA	Ecole Nationale Supérieure des Techniques Avancées
EURASAP	European Association for the Science of Air Pollution
HDR	Habilitation à diriger des recherches
IAEA	International Atomic Energy Agency
IER	Institut für Energiewirtschaft und rationelle Energieanwendung (University of Stuttgart, Germany)
INERIS	Institut National de l'Environnement Industriel et des Risques
INRIA	Institut National de Recherche en Informatique et en Automatique
INSU	Institut National des Sciences de l'Univers (CNRS)
IPSL	Institut Pierre-Simon Laplace
IRSN	Institut de Radioprotection et de Sûreté Nucléaire
ISORROPIA	Equilibrium in Greek ; équilibre en grec
LCPC	Laboratoire Central des Ponts et Chaussées
LEFE	Les Enveloppes Fluides et l'Environnement (CNRS/INSU Program.)
LSCE	Laboratoire Surveillance du Climat et de l'Environnement (CEA / CNRS)
MAM	Modal aerosol model
ONERA	Office National d'Etudes et de Recherches Aérospatiales
PAM	Pollution Atmosphérique Multiphasique
PNCA	Programme National sur la Chimie Atmosphérique
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
PROMOTE	Protocol Monitoring for the GMES Service Element
R2DS	Réseau de recherche sur le développement soutenable
SFEN	Société Française de l'Energie Nucléaire.
SIREAM	Size-resolved Aerosol Model
SIRTA	Site Instrumental de Recherche par Télédétection Atmosphérique
STIC-AmSud	Sciences et technologies de l'information et de la communication – Amérique du Sud



agence d'évaluation de la recherche  
et de l'enseignement supérieur

Section des unités de recherche

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## Grille d'évaluation d'une unité ou équipe de recherche.

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- 22 juillet 2008 -

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## Grille d'évaluation d'une unité ou équipe de recherche

Une version initiale est remplie par le directeur d'unité et une version finale est validée par le président du comité de visite, ce n'est pas un document public.

**UNITE : CEREA**

**EQUIPE OU PROJET :**

**NB :** Cette grille a été préparée pour l'ensemble des domaines scientifiques et seules les notions pertinentes sont à prendre en compte dans chaque discipline.

### Profil quantitatif de l'Unité ou de l'Equipe

Personnels au 15/10/2008	Nombre	Remarques
Personnels permanents chercheurs	11	
Dont Universités		
Dont Organismes	4	
Dont Ecoles	4	
Dont autres	3	
Dont PR/DR	2	
Dont MCF/CR	5	
Dont titulaires de l'HDR	2	
Dont titulaires de la PEDR		
Dont membres de l'IUF		
Dont autres	4	
Personnels non permanents chercheurs	12	
Dont invités		
Dont Post-doctorants	4	
Dont doctorants	8	
Personnels Support	11	
Dont Personnels administratifs	2	
Dont Personnels techniques	2	
Dont Ingénieurs	7	
Dont autres		
<b>Production scientifique du 15/10/2004 au 15/10/2008 sauf quand l'unité a été créée entre temps</b>		
• Publications référencées par l'AERES		
Dont Revues	53	
Dont Conférences	56	
Dont livres et Ouvrages	2	
Dont autres	207	
• Productions/Réalisations		
Dont logiciels enregistrés		
Dont Brevets et licences		
Dont instruments *		
Dont Contrats industriels	2	
Dont autres	2	films
<b>Descripteurs</b>		
-Nombre de publiants :	8	
-Thèses soutenues en moyenne par année durant le contrat écoulé :	3	
-HdR soutenues en moyenne par année durant le contrat écoulé :	0,5	

\* réalisation expérimentale originale

**Date :** 26 septembre 2008

**NOM :** Christian Seigneur

## Profil qualitatif

COMMENT EVALUEZ-VOUS ? : 1. médiocre --- 5 : excellent	5	4	3	2	1	sans objet
<b>LE BILAN :</b>						
1. L'originalité et l'intérêt des recherches	✓					
2. Le niveau et la notoriété des publications scientifiques, le rayonnement de l'unité ou de l'équipe et de ses membres ...	✓					
3. L'avancement des savoirs, de l'expertise ou de l'impact technologique de l'unité ou de l'équipe	✓					
4. La qualité des réalisations scientifiques (logiciels, instruments, méthodologie, base de données, outils, plateforme....)	✓					
5. L'importance, la pertinence des partenariats scientifiques, le positionnement dans les réseaux nationaux et internationaux appropriés	✓					
6. L'existence de sujets de recherche émergents			✓			
7. La présence et le soutien à de jeunes chercheurs prometteurs	✓					
8. L'importance, la pertinence des relations partenariales avec le monde socio-économique	✓					
9. La qualité des connaissances opérationnelles produites, le transfert et valorisation socio-économique des recherches.	✓					
10. La contribution de l'unité ou équipe à l'école doctorale, à la formation par la recherche, à la formation licence et master	✓					
11. La contribution à la diffusion des connaissances et de la culture scientifique, à la veille sociétale, à la production d'expertises scientifiques pour l'appui aux politiques publiques			✓			
12. La gouvernance, la cohérence et la vitalité de l'unité	✓					
<b>LA PROSPECTIVE ET LE PROJET</b>						
13. La qualité des projets, la pertinence des objectifs proposés par l'unité ou l'équipe au regard de ses missions, de sa taille, de son organisation et de sa capacité à avoir réalisé son projet précédent	✓					
14. La politique d'incitation à l'émergence de sujets innovants, à la prise de risque et aux sujets frontières	✓					
15. La politique d'animation de l'unité ou de l'équipe, la politique de recrutement, l'analyse prospective à moyen et long terme des besoins et des compétences	✓					

Date : 26 septembre 2008

NOM : Christian Seigneur

### Commentaire de l'expert

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