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FRONT PAGE

Dennis Tsichritzis, Chairman of the Board at GMD, the German National Research Center for Information Technology and President of ERCIM: New Times, new Challenges.

This August I am stepping down as ERCIM President after two terms. ERCIM has enlarged with more members. The relationships between the Institutions are deeper and we see many new projects. We avoided creating a heavy central administration, our office in Paris is lean and effective. Finally, the membership fees have dropped twice and we are running a surplus. In short, we have achieved a European dream.

We live, however, in interesting times. We have achieved much but there are new challenges facing all of us.

The integration challenge: Basic and Applied Research cannot run separately in our area. Every idea should have a chance to be relevant and the applications push our concepts to the limit. Interleaving structurally and dynamically Basic and Applied Research is a challenge.

The impact challenge: Our area is booming. There is so much activity and so many diverse interests, that it is difficult to make our mark. We represent a very small portion of total R&D most of which runs in the private sector. We need a great effort to be visible and credible.

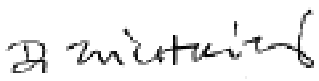
The innovation challenge: There is a demand pull from the marketplace for technological innovation. We need to position ourselves in the innovation chain which provides at the end companies, jobs and wealth for our society.

The qualification challenge: Our area expands so fast that it is lacking qualified people. We need to provide solutions of lifelong learning both for people being pulled from other areas and our own people needing constant retooling.

The acceleration challenge: Everything regarding our area is moving extremely fast. All our processes from starting projects, repositioning, technology transfer to phasing out activities need to be constantly accelerated.

The versatility challenge: Our area is becoming a key component in many new activities combining disciplines, eg Bioinformatics, Bioinformation, etc. We need to be versatile to work together with other disciplines and to defend our share in the new developments.

All these new challenges should not derail us from our core business which is to provide quality Research in Information Technology. If you think that all this is hardly possible, then think of what was achieved in the last thirty years. At the time not only it was considered impossible, but not anybody could even dream of it.



Dennis Tsichritzis

SPECIAL :

C O N T E N T S

Next Issue:

Advanced Databases and Metadata

ERCIM Executive Committee 1995 – 1998

by Christos Nikolaou and Constantine Stephanidis

From September 1995 to August 1998, Christos Nikolaou chaired the ERCIM Executive Committee, succeeding Bob Hopgood, the first chairman of the committee. During this period, Constantine Stephanidis served as the ERCIM Executive Committee Secretary.

ERCIM is now a well-known actor in the European and international Information Technology scene. In the past three years, five new European institutes have joined ERCIM, expanding its geographical coverage and its scientific scope. But there was also the withdrawal of AEDIMA, the Spanish consortium in ERCIM. It is very much hoped and widely expected that a Spanish representation will soon re-join ERCIM.

ERCIM has established co-operation activities at an international level, has acted as a consultant to the European Commission, to international organisations and national/local governments, and has contributed to the strengthening of the European R&D in the Information Technology field. This role should be maintained and encouraged.

Christos Nikolaou

Constantine Stephanidis

The ERCIM Executive Committee has initiated a number of actions to improve the organisational structure and strengthen the co-operation between the member institutes. Along this line, specific responsibilities have been assigned to members of the Executive Committee, resulting in a more co-ordinated and team-oriented operation.

The ERCIM Working Groups and the ERCIM Office have emerged as engines of ERCIM growth through competitive bidding and successful funding of ERCIM proposals. There are now fourteen working groups (versus six in 1995) that cover a wide scientific area, organising conferences and workshops, establishing standard co-operation procedures and dissemination activities, and giving birth to collaborative projects between the participating institutes. Both ERCIM Office and Working Groups should maintain and strengthen their momentum. In particular, the ERCIM Working Groups should be strongly encouraged to seek ERCIM co-ordinated projects more aggressively.

The figures of the ERCIM overall budget have increased, rising from 1,5 MECU in 1995 to 3,3 MECU in 1998. The projection for this calendar year is that ERCIM will attract over 2 MECU funding from the European Commission, versus 600 KECU in 1995, and show a carry forward of 750 KECU in 1998.

ERCIM's visibility has grown significantly through the exploitation of the Web, the improvement of ERCIM publications, and the involvement of ERCIM in international bodies (such as W3C and VRML Consortia) and as consultant in EC sponsored or co-ordinated technical and policy committees and working groups.

An ERCIM Internet domain has been set up (ercim.org), providing the electronic door to the activities and operation of ERCIM, while restricted web sites have been established to support the internal activities and co-operation between the ERCIM members. The ERCIM Web server has been re-structured, and now offers a wide range of information, concerning working groups, the digital library initiative, workshop sponsorship, fellowship programme, the Cor-Baayen award, ERCIM co-ordinated projects, ERCIM events, and ERCIM publications (ERCIM News, technical reports, workshop proceedings, strategic reports, ERCIM members' libraries). The ERCIM News (both in paper and electronic form) proved to be a very successful tool for the dissemination of information about ERCIM research activities, views and policies.

The commitment to the provision of an ERCIM Virtual Laboratory was followed, but not fulfilled. Lack of funding and inadequate European research networking infrastructure have frustrated ERCIM efforts to become a Pan-European Virtual Laboratory, where new technologies, such as the electronic marketplace, digital libraries, distant learning, 'collaboratories', and virtual working spaces can be tested, piloted and seeded. In the next three-year period, ERCIM should become a more vocal and ardent advocate of the need for a decisive upgrade of the European networking infrastructure.

The significant progress made during the last three years was only possible because of the team spirit that prevailed in the Executive Committee and the constant encouragement and support given to us by the ERCIM Board of Directors and especially by ERCIM's President, Dennis Tsichritzis. We would like to acknowledge the active support of the Editorial Board through the ERCIM News, and the ERCIM European Liaison Officers Group for being a vital link of ERCIM to Brussels. We would also like to thank the ERCIM Office for the continuous efforts and commitment against growing overload. Finally, we wish our two colleagues, Eckart Bierduempel and Gilbert Kalb, who take over the chairmanship and secretariat of the Executive Committee respectively, every success in their new role and exciting mission.

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ERCIM Meetings at GMD

by Siegfried Münch and Eckart Bierdümpel

Slovakia is the fifteenth member of ERCIM. On 29 May 1998, the Slovak Research Consortium for Informatics and Mathematics (SRCIM) joined the European Consortium of national informatics research institutes. The Director of the Department of Computer Science of the Comenius University, Bratislava, Prof. Dr. Banislav Rovan, and the Directors of the ERCIM member institutes signed the membership agreement during this year's spring meeting of ERCIM held from 25-29 May 1998 at GMD's headquarters in Sankt Augustin. About 100 computer scientists participated in this meeting.

Three workshops held on 26 May discussed the following subjects which are important to the development of common ERCIM research focuses:

- health information technology
- fluid mechanics
- database technology.

The Executive Committee met on 27 May. They prepared the 10th anniversary of ERCIM and discussed the recruitment of additional personnel for the ERCIM Central Office, the reports on work group activities, the fellowship programme and the acceptance of new members. Another subject of the discussion was the election of a new chairman since the chairmanship of Christos Nikolaou, FORTH, will end by August, 1998. Eckart Bierdümpel from GMD was suggested as candidate for chairmanship and Seppo Linnainmaa from VTT as candidate for vice-chairmanship.

On 28 May, GMD presented some of its activities. Martin Reiser, head of the Institute for Media Communication gave an overview of current projects. The institute combines the key technologies of multimedia and telecommunication areas to develop innovative applications for the fast growing market of electronic media and the Internet.

Projects of the System Design Technology Institute were presented by Thomas Christaller, eg in the fields of robotics and artificial intelligence. Thomas Lengauer reported on the activities of the Institute for Algorithms and Scientific Computing to develop methods and tools for the computer simulation of complex applications in natural science. His presentation focused on activities in the field of molecular bioinformatics.

A tour of the institutes enabled the visitors to gain insight into four activities: Cyberstage and the Virtual Studio, GMD's Net Lab, the support of cardiologic diagnosis by enabling systems and 3D ultrasound and new results of the development of shared workspaces in the World Wide Web as basic support for cooperative work.

The ERCIM meetings ended with a meeting of the Directors on 29 May. The subjects of discussion were the 1997 management report of the ERCIM office and the consolidated budget. The outgoing chairman of the Executive Committee, Christos Nikolaou, presented the report on the past six months. In addition, the Committee discussed legal problems and possible activities to be planned for the 10th anniversary of ERCIM in 1999.

As successor of Dennis Tsichritzis from GMD who was ERCIM's President for four years, Gerard von Ortmerssen, CWI was elected ERCIM President. Stelios Orphanoudakis from FORTH and Pekka Selvennoinen from VTT were elected vice-Presidents. The Executive Committee's suggestions for the election of the chairman and vice-chairman were accepted.

The next ERCIM meetings will be held in the first week of November in Amsterdam.

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Participants of the meeting of ERCIM's board of Directors. Left to right: Pekka Silvennoinen, VTT; Gordon Walker, CLRC; Eldfrid Ovstedal, SINTEF Telecom and Informatics; László Monostori, SZTAKI; Rainer Berling, SICS; Gerard van Oortmerssen, CWI; Jiří Wiedermann, CRCIM; Carl August Zehnder, SGFI; Branislav Rovan, SRCIM; Bernard Larrouturou, INRIA; Dennis Tsichritzis, GMD; Stelios Orphanoudakis, FORTH.

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New ERCIM Working Group Fluid Mechanics established

by Ullrich Becker-Lemgau

The kick-off meeting of the new ERCIM working group on Fluid Mechanics was held in GMD, Sankt Augustin, 26 May 1998. It was hosted by the Institute for Algorithms and Scientific Computing of GMD.

So far four ERCIM institutes participate in the new working group:

- CWI, Computational Fluid Dynamics Group
- FORTH, Institute of Applied and Computational Mathematics
- INRIA, research team M3N – Multi-Models and Numerical Methods
- GMD, Institute for Algorithms and Scientific Computing.

Two main research areas in the context of Computational Fluid Dynamics were chosen to build the focus of the working group:

- multidisciplinary applications (coupling)
- shallow water equations (numeric, solver, applications).

Especially multi-disciplinary applications were given much potential for the near future. In nearly every area of applications covered by the participating institutes the need for tools and numerical algorithms to solve coupled problems is increasing. The main focus of the working group will be the definition of a joint project and the organisation of a workshop as a result of this project. Research groups of other ERCIM institutes that are interested in joining the working group are requested to contact the chairman. For more information, see: http://www.gmd.de/SCAI/scicomp/ERCIM/fluid-dynamics

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Third ERCIM Environmental Modelling Group Workshop

by Thomas Lux

The third workshop of the ERCIM Environmental Modelling Group on Air Pollution Modelling and Measuring Processes was held in Madrid, Spain, on 20-21 April 1998. The workshop was hosted by the Environmental Software and Modelling Group of the Computer Science School of the Universidad Politecnica de Madrid (UPM). The workshop chairman was Roberto San José (UPM).

The lectures and discussions at the workshop focussed especially on the importance of the linkage between the modelling processes and the measuring tools. Measurements play two significant roles in air pollution modelling. At first, the usage of measured meteorological, emission and background concentration data as input for air quality simulations obviously influences the quality of the simulation results, especially for air quality forecasts. At second, measurement data are one of the basic preconditions for the validation of air quality models. As highlights of the program, invited lectures of representatives of the local environ-mental authorities of the State of Madrid and the State of Brandenburg (Germany) were given . The participation of these invited speakers was supported by the ERCIM Office.

A special item of the workshop program was a round table discussion about the further activities of the ERCIM Working Group Environmental Modelling, led by the working group chairman Achim Sydow. Nikolaos Kampanis from FORTH, Institute of Applied and Computational Mathematics (IACM) agreed to organize the next workshop at his institute in Heraklion, Crete, Greece. The proposed date of the 4th workshop is the time between mid October and mid November this year. Proposed topics, as discussed in Madrid, are the validation of environmental models, model comparison, data mining, ecological/ economical impact analysis and problems of sustainable development.

Moreover, the submission of future project proposals was rised, and the preparation of the ERCIM-NEWS issue number 34 with the special theme Environmental Modelling was discussed. The program was wound up by a tour of the Computer Science School at UPM, and by a common dinner in a typical Madrid restaurant. Detailed information about the workshop program and the participants can be found at http://artico.lma.fi.upm.es/ercim.html

Participants of the ERCIM workshop on Air Pollution Modelling and Measuring Processes.

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First ERCIM Health and Information Technology Workshop

by Vesa Pakarinen

The first workshop of ERCIM Working Group Helath and Information Technology (HIT) was held on 26 May during the ERCIM-week at GMD in Sankt Augustin, Germany. The participants came from six different ERCIM member organisations: CLRC, FORTH, GDM, INRIA, SGFI and VTT. In addition, INESC had sent their written contribution.

Invited speaker, Peter Fatelnig from European Commission (Directorate-General XIII: Telecommunications, Information Market and Exploitation of Research:Telematics application for health) gave information about the Background & Status of the activities on the preparation of the 5th Framework Programme. The introductions and discussions at the workshop took also note on the Report of the Strategic Requirements Board (Health Telematics) that is available at http://www.ehto.be/ht_projects/report_board/index.html

The purpose of the workshop was to exchange ideas for possible co-operation for the future project proposals among ERCIM members. It was also decided that ERCIM members may contact each other directly about mutual interest areas. However, the chairman should be informed also to avoid overlapping proposals. All the introductions and the program itself are linked through ERCIM-pages and can be seen at http://www.vtt.fi/tte/tre/projects/ercim/workshop.htm

In the planned Thematic Program *Creating a User-Friendly Information society* (TP2) one of the key actions is Systems and Services for the Citizen. The aim of this key action is to provide users with easier access at the lowest cost to quality general-interest services and boost the industry providing these services. Concerning the priorities of *Health and ageing, disability and other special needs*, the objectives are:

- new generation computerised clinical systems
- advanced telemedicine services
- health network applications to support health professionals, continuity of care and health service management
- intelligent systems and services allowing citizens to assume greater participation and responsibility for their own health.

RTD priorities for professional health care contain:

- systems enhancing the ability of health care professionals for prevention, diagnosis, care and rehabilitation, eg intelligent systems for non-invasive diagnosis and therapy, intelligent medical assistants, advanced medical imaging, advanced telemedicine applications, 'virtual hospitals' offering single point-of-entry services, high-speed secure networks and applications for linking hospitals, laboratories, pharmacies, primary care and social centres for continuity of care, health service workflow management and re-engineering, new generation electronic health records and cards for sophisticated health data objects:
- systems for personal health monitoring and fixed or portable prevention systems, including advanced sensors, transducers and micro-systems
- personal medical advisors for supervision of prevention and treatment
- tele-systems and applications for supporting care in all contexts
- user-friendly and certified information systems for supporting health education and health awareness of citizens.

Information is available at www.ehto.be and at www.cordis.lu/fifth/src/docs.htm

The chairman wishes to invite more ERCIM colleagues to the work, please spread the word and kindly ask people to subscribe on emails. ■

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Third ERCIM FMICS International Workshop

by Diego Latella

The third ERCIM International Workshop on Formal Methods for Industrial Critical Systems (FMICS) was held at CWI, Amsterdam, on 25-26 May 1998.

The success of the meeting was evidenced by the lively discussions and exchanges of opinion between the approximately 40 participants from both academia and industry. Four invited speakers gave the following talks:

- Wam J. Fokking – Univ. of Wales Swansea, United Kingdom: 'Verification of Interlockings: from Control Tables to Ladder Logic Diagrams'
- Gea Kolk – Holland Railconsult, The Netherlands: 'Formal Methods: Possibilities and Difficulties in a Railway Environment from a User Perspective'
- Hubert Garavel – INRIA Rhone-Alpes, France: 'Towards a Second Generation of FDT – Rationale for the Design of E-LOTOS'
- Rance Cleaveland – North Carolina State University, USA: 'Verifying Active Structural Control Systems: a Case Study in Formal Analysis'.

14 additional presentations were given on various aspects of formal methods and their application to case studies.

During the meeting a report was delivered on the status of the Working Group:

- a special issue of the Kluwer AP Journal on Formal Methods in Systems Design dedicated to the 1st FMICS workshop (Oxford, March 1996) has been published (Vol. 12 n. 2)
- a special issue of the Springer Journal on Formal Aspects of Computing dedicated to the second FMICS workshop (Cesena, July 1997) is now in preparation
- a special issue of the Elsevier journal on Science of Computer Programming on the Application of Formal Methods to the Industry which contains contributions from Working Group members is also forthcoming
- an ERCIM fellowship in the field has been granted at INRIA and CWI.

The Proceedings of FMICS '98 were published by CWI (ISBN 90 6196 480 6) while a selection of the papers presented during the workshop will be published in a special issue of Formal Aspects of Computing.

GMD-FOKUS and CNR have both offered to organize FMICS'99. A decision will be taken soon.

For more information on the FMICS Working Group of ERCIM, see: http://fdt.cnuce.cnr.it/~latella/FMICS/WgDescription.html

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ERCIM Working Group on Programming Language Technologies

by Neil Jones

The constitutory meeting of this brand-new ERCIM Working Group will be held in Pisa, Italy on Saturday, 19 September. This is the same place and just after the cluster of conferences SAS, PLILP, and ALP. All interested ERCIM members are encouraged to attend. If you plan to bring a guest, please contact the workshop organiser (see address below).

Topics to be discussed at the first meeting will include projects, proposals, summer schools, internal mobility and fellows, and future workshops.

We have a high expectation of strong interactions. This is partly due to the fact that we already know many professional colleagues within the ERCIM partners from other contexts. Further, we look forward to new and fruitful contacts in our area, which we feel will become a locus of significant activity within ERCIM.

Possible topics include but are not limited to:

- Compiling and implementation: program analysis, abstract interpretation, program control flow and data flow analysis.
- Model-specific issues concerning: functional, logic, object-oriented, parallel, and distributed programming.
- Program manipulation techniques: program transformation, partial evaluation, program synthesis.
- Programs as data objects: meta programming, incremental computation, correctness of compilers, interpreters, instrumenters, etc.
- Tools, techniques, and representations: program and code representations, proof-carrying code, tools for program manipulation including analysis, prototyping and debugging.

A preliminary WWW page can be found at http://www.diku.dk/users/neil/PL/

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Eleventh ERCIM Database Research Group Workshop: Metadata for Web Databases

by Brian J Read

The latest in the series of ERCIM Database Research Group workshops was held at GMD Birlinghoven Castle near Bonn on 26 May 1998. The topic 'Metadata for Web Databases' attracted significant interest among members of the working group, resulting in a very full day of presentations and discussion. Karl Aberer of GMD-IPSI organised and chaired the workshop. There were sixteen participants from ten institutes.

In the context of Web data management, database systems are mostly used in an isolated way as data sinks or sources. Data management services that exploit and support the connectivity of the Web require the interaction and co-operation of different data management components on the Web. To enable this the Web needs to be equipped with the metadata on structure and behaviour of Web data that these components require. Thus the workshop was intended to address such questions as the extraction, modelling and querying of metadata, so adding semantics to the use of web data.

Keith Jeffery (CLRC-RAL) introduced the workshop topic by presenting an overview of the nature of metadata in databases, distinguishing its various purposes, and classifying it into three main kinds: schema, navigational and associative. Capturing metadata from the web presents problems as virtual pages generated from database queries are invisible to the large web crawlers. The limitations of HTML, and indeed XML, in managing metadata were discussed in this and several subsequent talks.

Yannis Stavrakas (NTU-Athens) expanded on the nature of metadata for web-based information systems. He distinguished three perspectives corresponding to the atomic level (information within a page or document), the local level (the structure of a site and links between documents), and the global information space of the whole web.

Terje Brasethvik (IDI/NTNU-Trondheim), currently in Paris, described his work with Arne Sølvberg on a Referent Model of Documents classified by semantic metadata. In this approach to sharing information on the web, they are developing a modelling language and editor to capture the meaning of documents.

Giuseppe Sindoni (Rome III University), currently visiting RAL, presented work from Paolo Atzeni's Rome group on a logical model for metadata in web bases. Their Araneus Data Model with the Penelope language embeds the schema within HTML. Turning to XML is potentially attractive, but that too has limitations for data modelling.

Three research projects were covered in the afternoon session. Menzo Windhouwer (CWI) described the work with Martin Kersten on the Acoi project. This is developing a feature detector engine to classify multimedia objects, especially images. The Acoi web robot has already stored in a database details extracted from over two hundred thousand images.

Thomas Klement (GMD-IPSI) spoke about the ICE (Information Catalogue Environment) project. This concerns metadata for multidimensional categorisation and navigation support on multimedia documents. It includes an interesting use of dynamic menus to explore hypercube structures stored in an object-relational database.

The last presentation was from Donatella Castelli (CNR-Pisa) about supporting retrieval by "relation among documents" in the ERCIM Technical Reference Library (ETRDL) based on the Dienst system and the Dublin core. This provided an interesting discussion on the possible semantics of a relationship defined between documents.

The workshop concluded with a lively panel and discussion session on the future research direction of EDRG and also its role in the EC Fifth Framework Programme. A relevant component of the latter is "Creating a User Friendly Information Society", especially Key Actions relating to application domains. This suggested that future workshops might be targeted towards an application area (such as transport, environment or health) instead of a technical topic. CWI emphasised semantic indexing of the web, in particular by involving the end user, in an ambitious research agenda and cautioned against being too much influenced by funding considerations.

The workshop papers will be published in the ERCIM reports series (http://www.ercim.org/publication/workshop_reports.html).

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Environmental Modelling and Simulation Research

by Achim Sydow

Information technology has played an increasing role in the planning and controlling of environmental issues at different scales and within various time spans. It has been a long journey from the establishment of ecology as a science dealing with the relations of organisms to their environment (Haeckel, 1866) and the definition of the concept of ecosystems (Tansley, 1935), to the development of our field of computational ecology. Rapid developments in information technology made the establishment of computational ecology possible and continue to accompany our research endeavours.

Environmental systems consisting of geophysical and geochemical elements, abiotic factor complexes (atmosphere, hydrosphere, pedosphere) and biotic elements (growth processes, population dynamics) are real complex systems. Information technology has succeeded in developing adequate tools for modelling, simulation, planning and decision support for environmental protection. As a result, education aimed toward transmitting an understanding of environmental systems is nowadays unthinkable without the use of computer techniques.

Considerable progress has been reached in a number of different research areas:

- in theoretical areas, the use of High Performance Computing simulation has brought spectacular results in systems dynamics (evolution strategies, logistic growth, chaos research)
- in climate research, the long term analysis of global change
- in economics and ecology, the considerations of sustainable development
- in mathematics, the development of powerful algorithms for integration and decomposition methods for parallelization.

CONTENTS

Interdisciplinary co-operation has benefited from computer networking. Parallel computation greatly assists in the efficient analysis of large scale and complex environmental systems. Weather and ozone forecasts are based on parallel computation. Visualization techniques allow comprehensive overviews and thus assist decision support. Simulation gives numerical insight into the behaviour of complex environmental systems. Intelligent information technologies (neuronal nets, evolution strategies, expert systems) support modelling should relevant background structures from the natural sciences be unavailable. These information technologies can also assist data mining. Algorithms for optimization and poly-optimization provide a helpful aid for dealing with conflict situations which can evolve between the areas of ecology, economics and the needs of society.

The articles in this issue of ERCIM-News reflect the wide range of research and applications conducted within the ERCIM community in the field of environmental modelling and simulation:

- analysis of regional systems
- climate research
- air pollution modelling
- water pollution modelling
- modelling of natural resources
- modelling of traffic systems
- methods for modelling and optimization
- mathematical methods, partial differential equations
- simulation tools
- environmental risk management
- data management
- data mining
- visualization
- intelligent cartography.

The ERCIM working group Environmental Modelling provides a platform for the discussion of results in this area and promotes further research. In addition to national research programmes the European Commission is actively supporting this research. ■

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Data Management in Climate Research

by Kerstin Kleese

Parallel environmental models are currently some of the most demanding codes we have. They push the machines available to their limit and are still in need of more resources. However the bottleneck in running these codes is not so much the code performance as the data handling strategies employed. The High Performance Computing Initiative Centre at CLRC, Daresbury Laboratory (UK) is setting up a new project to investigate this important issue. Besides analysing existing solutions, the project will also look for new, more flexible and portable approaches.

The UK environmental research community relies heavily on High Performance Computing (HPC) to facilitate its studies. Fortunately the environmental model codes have a large potential for parallelization, which has been well explored by numerous research groups in the UK (eg UGAMP and OCCAM). Still increased resolutions, longer runs or larger ensembles have a significant impact on the HPC resources required and can easily overwhelm current systems. Often data handling has the most dramatic influence on model run times or determine whether a model can be run at all. Thus optimal data handling is vital for this type of application. Unfortunately the problems do not stop with the end of a successful model run. These codes produce vast amounts of data which have to be archived for future analyses. Current data storage systems leave something to be desired in speed and ease-of-use. The situation for data retrieval is even worse. Tedious searching for archived data, long waiting times and no selective extraction possibilities are common problems for modern scientists. Sometimes it is faster to run a model again instead of retrieving data from a previous run.

It is already clear that the data requirements of the community will increase even more over the coming years. Big centres like the European Centre for Medium Range Weather Forecast expect the volume of their data archive to double every 18 months. New machine architectures allow potentially larger models to be run. Data handling presents a severe bottleneck for today's science, without new strategies it might prevent future progress.

First steps

For our project it was decided to take a holistic approach, identifying four main areas of interest:

- data handling within the model codes
- file access during run time (on different platforms)
- data archival
- data retrieval.

Although all these areas have been investigated separately, and some interesting in-house solutions exist, little has been done to offer a portable solution that can be easily adapted to the actual requirements of different sites.

The first step is to analyse the current situation. Research results of leading scientific groups concerning data handling strategies within model codes have been examined. A lot of work has been done in this area over the past years, and we can certainly benefit from that. We would like to compare the different

More intelligent solutions for data archival and retrieval systems are needed.

approaches, trying to find similarities, differences and tendencies that could be useful for the community. Secondly a list is in preparation covering the different file access mechanisms during run time on various systems. This gives a clear overview about what is available, how fast is it and what the user can do to make the most of it. This information will serve as a base for further investigations. In connection with vendors and other sites we have started to gather more information about the data archival and retrieval systems that are in use today. The clear message so far is that there is a desperate need for more intelligent solutions.

Future

Our project will continue to analyse existing solutions. It will test which data handling strategies within model codes are best for which type of application. We will frequently investigate new machines or relevant changes to existing system architectures. A collaboration with a leading systems house has just started, to determine which off-the-shelf products could be used to provide more flexible data archival and retrieval mechanisms for scientific data.

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Performance Prediction Studies and Adaptive Refinements for Local Area Weather Models

by Kläre Cassirer, Reinhold Hess, Wolfgang Joppich and Hermann Mierendorff

The new generation of numerical weather prediction models is designed for parallel machines. Since the development of such a code can take several years of time, the increase of computer power during this time frame has to be considered in the design. But there is not only an increase of computational power, further on also research on new and faster algorithms takes place in order to predict the weather even more accurate and reliable in the future. Current activities within the theme cluster METEO of GMD Institute for Algorithms and Scientific Computing concentrate on performance prediction studies for meteorological models and algorithmical research on local adaptive refinements.

Numerical weather forecasting and climate prediction require enormous computing power to achieve reliable results. Six of the twenty-six most powerful computer systems in the world are dedicated to weather research (November 1997). All of them are parallel architectures with the number of nodes ranging between 64 and 840.
In order to exploit this high computing power existing codes have to be adapted to parallel computers, and new parallel algorithms are developed.

After the year 2001 the operational Local Model (LM) of the Deutscher Wetterdienst (DWD) will run in a horizontal resolution of approximate 3 km mesh size by 50 vertical layers and with time steps of only 10 seconds. Since a one-day prediction on about 800x800x50 grid points has to run within half an hour of real time in the operational mode, enormous computing power is demanded.

Currently no available machine in the world can fulfill these computational requirements, and direct run-time measurements for the LM with the operational resolution are not possible. Therefore, a study was initiated to predict the performance of the LM and to define specifications of adequate parallel systems.

The computational complexity was modelled with series of LM-runs on an IBM SP2 with up to 32 nodes using different spatial and temporal resolutions and different numbers of processors. In a least square approximation the coefficients for approximation functions were determinated. With calibration runs of the LM with lower resolution the model could be scaled for various existing machines. These run-time measurements are presented in the figure 1. Note, that different parts (computation and physics) of the LM scale in a different way, a model for each individual part was set up therefore.

The communication requirements were determined by a structural analysis of the LM. The communications, the number and of sizes of the messages to be exchanged, were parameterized by the size of the global grid and its partitioning. For existing machines the communication model is based on communication benchmarks. However, standard benchmarks measuring ping-pong, etc., were not fully sufficient and a special communciation benchmark measuring the special data exchange of the LM had to be implemented. Hypothetical architectures can be modelled by assumed characteristics for computation and communication, as sustained flop rate, latency and bandwidth.

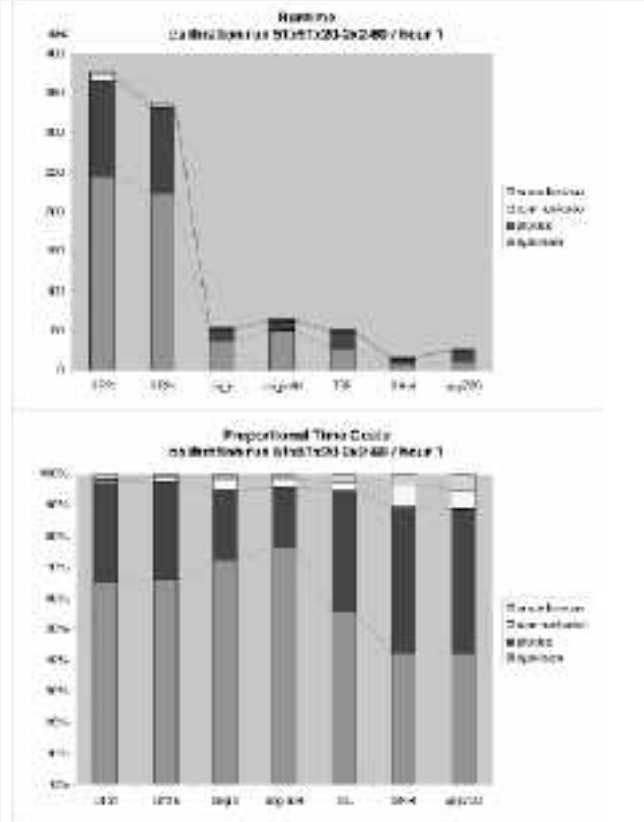
As a result of the study, the predicted required computation demands are tremendous. Indeed, no currently

available machine meets the requirements mentioned above. A hypothetical parallel computer at least requires 1024 nodes with 8-10 GFlops each and a network with about 250MB/s bandwidth. However, it can be assumed, that in the year 2001 machines of this style will be available on the market.

From these requirements for an operational system it becomes obvious, that algorithmical improvement of meteorological models is very important. Since also new numerical models have to run on parallel systems, parallelism becomes a very important factor for modern algorithms beside numerical efficiency.

A promising idea is to apply dynamically adaptive local refinements to numerical weather simulations. The computational costs could be essentially reduced, when high resolutions are provided only where it is necessary (eg weather fronts, strong low pressure areas). Calm regions could be calculated with a lower mesh size. However, since the weather situation is changing during the simulation, the refinement areas have to be adapted in time.

For the Shallow Water Equations, which build the dynamical core of numerical weather predictions, a parallel local model with dynamically adaptive local refinements has been developed and implemented. On a structured global grid, refinement areas are composed of adjacent rectangular patches, which are aligned to the global grid with refinement ratio 1:2. With a suitable mathematical criterion the refinement areas are dynamically adapted to the calculated solution.



Time measurements for calibration runs.

Major problems for parallel computers with distributed memory are the organization of data and the dynamical load distribution. Asynchronous, non-blocking communication is used in order to combine adaptivity and parallelism best in this approach.

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A Data Management and Visualization System for Coastal Zone Management of the Mediterranean

by Catherine Houstis

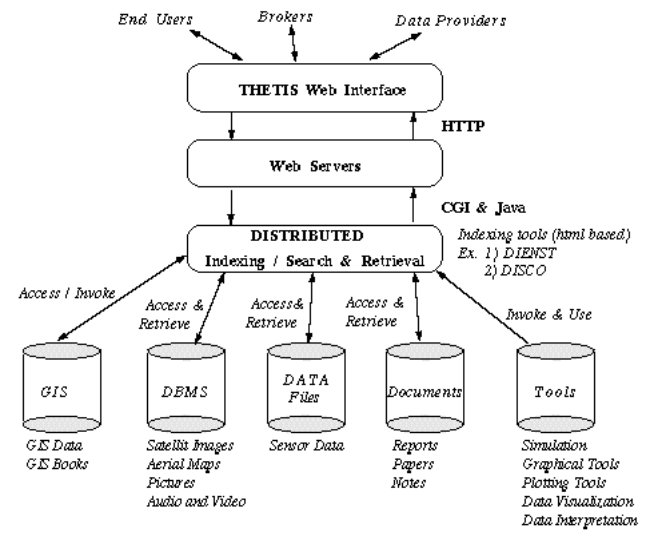
The Mediterranean coastal regions have been, and continue to be, under threat from over-exploitation, resulting in environmental degradation, most notably visible as marine pollution. THETIS is a 30 months research project starting in June 1998, that will establish a data management and data visualisation system for supporting Coastal Zone Management (CZM) for the Mediterranean Sea.

CZM is a methodology for the holistic management of all coastal resources with the ultimate aim of promoting sustainable development of the coastal zones. CZM recognises that pollution problems transcend political boundaries and so to be effective CZM requires the integration of multinational data collection, data management and data visualisation across many scientific disciplines such as marine biology, oceanography, chemistry and engineering.

The THETIS project seeks to address the frequent requirement of scientists, engineers and decision-makers to access, process and subsequently visualise data collected and stored in different formats and held at different locations. The need exists for tools that enable the integration of these data, together with their associated data models, interpretation models, and visualisation environments. The objective of the THETIS project is to build an advanced integrated interoperable system for transparent access and visualisation of data repositories, via the Internet and the Web. The system will be a working prototype,

which will demonstrate its ability to respond to users such as scientists and local authorities that use scientific information for decision making.

The technologies used at this project are Web tools, digital library indexing/search service, over the Web visualisation, 2D and 3D visualisation tools, Geographical Information Systems, Virtual Reality Modelling Language).



The components of the THETIS system architecture.

The expected benefits of the THETIS system for the users of the CZM application, the citizens and the European industries are very important. Integrated and easy access to information creates new services, thus new job markets. Integrated data repositories access and interactive use for CZM creates better coastal zone preservation with immediate impact to the European citizen.

Moreover, companies will be able to use the system to sell their information and create new integrated services for their customers. Consulting firms can make use of the THETIS system and tools to support their business. Finally environmental policies concerning the use of coastal resources can be monitored via the integrated information support and easy access of THETIS.

As shown in the figure, clients submit simple or complex queries via the Web interface (Web browser) to the system. User requests invoke various services such as metadata, index and search to locate the objects, which match the user-query. We assume that documents are stored in DIENST servers, and metadata services are provided to access them. The documents could be research papers written by scientists studying the coastal properties of the Mediterranean Sea. Images could be indexed via relational or object oriented databases in various formats. It is possible that the information about a region could be dispersed across several databases. This means that the information system has to index and search across the various databases to obtain the corresponding information. It is possible that information could be replicated across the databases. For this service, distributed search queries (via the Web) are sent to the various databases to obtain the objects. Metadata services describing the GIS objects are used to index/search for the appropriate GIS objects (multi-dimensional data and images). Distributed search agents collect/transform the various information objects and present the user with a composite result object.

The participants of the project are ICS-FORTH, ERCIM, INRIA, CNR, the Institute of Marine Biology of Crete (Greece), AEROSPATIALE (France), the IACM-FORTH (Greece), the University of Crete, HR Wallingford (United Kingdom), and RECORMED Network (France).

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A High Resolution Integrated Forecast System for the Mediterranean Sea

by Andrea Bargagli, Roberto Iacono, Sergio Nicastro, Paolo Michele Ruti and Franco Valentinotti

An integrated atmosphere-ocean forecast system, covering the whole Mediterranean basin, is being developed at ENEA (Italian National Agency for New Technologies, Energy and the Environment). The project, sponsored by the Department of Technical Services of the Italian Government, has two main goals: the high resolution forecast of the state of the Mediterranean Sea (in terms of surface wind, wave height and direction) and the prediction of flooding events in the city of Venice. The operational forecast system, which will be completed by mid-1999, will provide a useful tool for Civil Protection and, possibly, for other institutions involved in environmental surveying, coastal protection, navigation control and harbour management.

The integrated atmosphere-ocean forecast system for the Mediterranean, which is now being developed by the group for Atmosphere-Ocean Dynamics at ENEA, is shown in Figure 1. Predictions of the amplitude, frequency and direction of the sea-waves are obtained from a spectral wave model, while a two-dimensional grid-point model of the Adriatic Sea circulation, coupled with a shallow water, finite element model of the Lagoon, is used to predict the sea level in Venice. Both the wave and the ocean models are forced by the surface wind stress computed, at

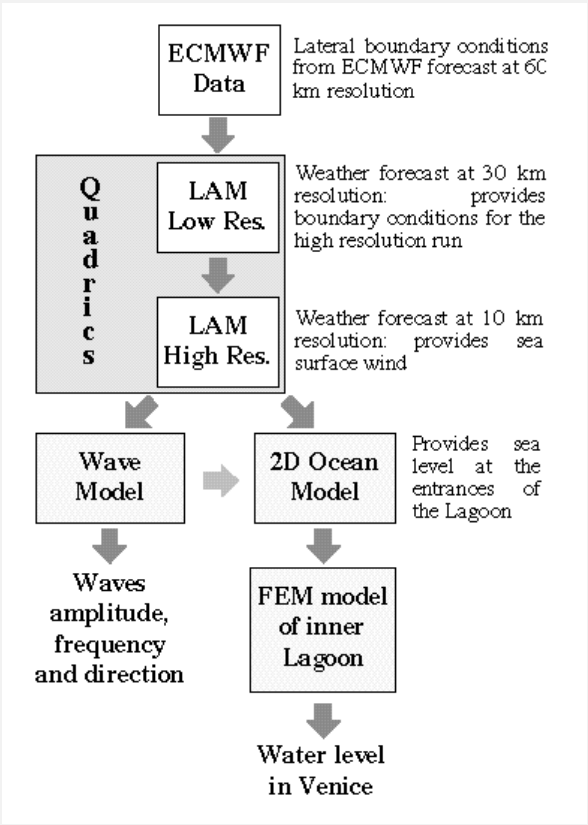

Figure 1: The flow-chart of the integrated operational system.

very high resolution (10 km), by a 3D meteorological Limited Area Model (LAM) running over the whole Mediterranean basin.

To satisfy the operational requirements (ie, a few days of forecast in a few hours), the meteorological model, which is by far the most demanding in terms of the computational effort required, was implemented on APE100/Quadrics, a massively parallel computer with a peak power of 25 billion floating point operations per second in the maximal 512 processors configuration.

In the operational configuration, an intermediate resolution run of the atmospheric model is performed, with a grid spacing of 30 km. This run takes initial and boundary data, at a 60 km resolution, from the global weather forecast produced every 6 hours by ECMWF (European Centre for Medium-Range Weather Forecasts) and provides the input data for the high resolution run of the LAM.

The wave model, which describes the evolution of the wave spectrum by solving the wave energy transfer equation, runs over the whole Mediterranean Sea at a constant resolution of about 30 km. On the other hand, the ocean model, computing the sea elevation at the entrances of the Lagoon, uses a variable resolution grid covering the Adriatic Sea, with grid size decreasing when approaching Venice.

Finally, a finite element, very high resolution model of the interior of the Lagoon is used to predict the water level in Venice. The mesh used by this model consists of about 7500 elements, with a spatial resolution varying from 1 km along the mud flats down to 40 m inside the channels.

Several experiments, performed to test the system performance, showed good agreement with observed data. As an example, we show the forecast of an extreme surge, which took place during November 1996, due to a strong cyclonic circulation over the Western Mediterranean region. A maximum sea surface elevation in Venice of about 1 m, very close to the measured one, was predicted for the 18th, at 6.00 am. In Figure 2, we show the corresponding wind field, as predicted by the meteorological model. A depression, initially located over Spain, has moved towards the East, causing the pressure gradient to align with the main axis of the Adriatic Sea, and therefore contributing to the sea level set-up in the northern part of the basin. Surface wind is driven by the surrounding orography and is directed along the same axis, blowing from the South-East.

Partners in the project are FISBAT-CNR of Bologna, the University of Padua and ISDGM-CNR, Venice.

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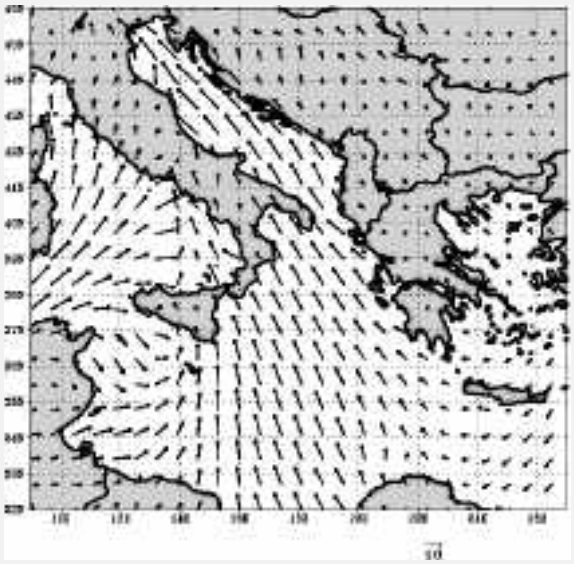


Figure 2: Simulation of surface wind (m/s) field: zoom over the Adriatic basin.

IDOPT: Identification and Optimization for the Geosciences

by Jacques Blum and François Le Dimet

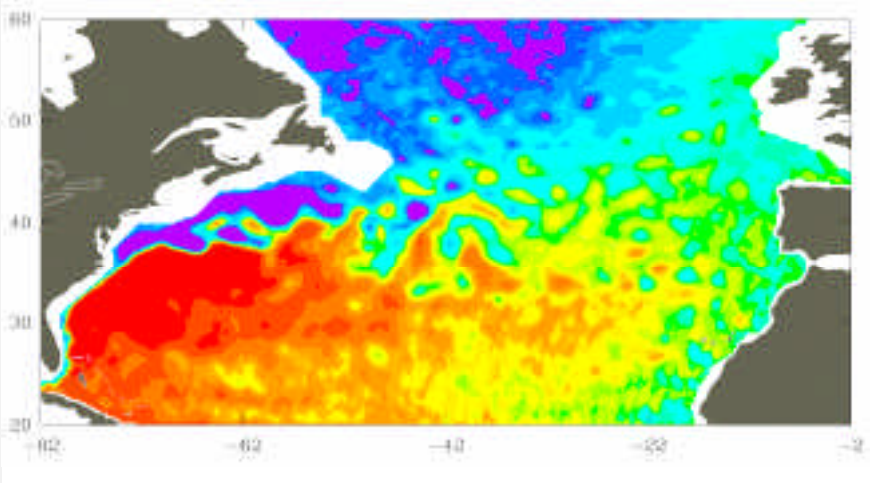
IDOPT is a joint research team of INRIA, CNRS, Université Joseph Fourier and Institut National Polytechnique of Grenoble. IDOPT is oriented towards the problems of identification and optimization of systems and their applications in physics and geosciences.

Geophysical fluids have some special problems which should be taken into account when they are modelled for the prediction of the evolution of the flows, for the atmosphere as for the ocean. Geophysical flows are governed by nonlinear laws and may have a turbulent behaviour. Therefore it is difficult to predict their evolution. It is also difficult to validate models with respect to experimental data. Finally the dimensions of the numerical models are huge. The operational prediction, eg the model used by the European Center for Medium Range Weather Forecast in Reading, UK, has several millions of degree of freedom. Therefore to carry out an efficient prediction in real time, fast numerical methods should be used.

The directions of research which have been developed by IDOPT since 1994 are adaptive grid modelling in oceanography and data assimilation in meteorology and oceanography.

Adaptive Grid Modelling in Oceanography

The problem of spatial resolution is a key point in ocean modelling, both in *climatic* or *operational* oceanography. From a climatic point of view, the simulation of the ocean's general circulation requires a grid size of typically 10-20 km, since many energetic phenomena occur at scales of a few tens of kilometres, or less. For operational oceanography, there exists presently a strong request for very high resolution local models. In this context, we are currently trying to exploit the multi-scale aspect of the ocean circulation to reduce the cost of numerical simulations. A package is being developped, which gives any finite difference ocean model the capability of adaptive gridding and local zooming. This is performed via the management of a hierarchy of grids of different resolutions, dynamically interacting together. An interesting point is that the model is seen as a black box, and thus has not to be modified. This approach is currently being tested in different ocean models.



Snapshot of the surface circulation in the North Atlantic in May 1997, computed by a numerical model assimilating Topex/Poseidon satellite data (source: LMC and LEGI,Grenoble).

Data Assimilation in Meteorology and Oceanography

The concept of Data Assimilation has emerged at the end of the 70's in the meteorological community. It was a response to the need that analyzed fields be in agreement with the dynamics of the atmosphere and take into account the various sources of information like heterogeneous data in nature, quality and density. Since then two main classes of methods have been considered:

Kalman-type methods: These methods are founded on the theory of estimation. They provide a sequential estimation of the field ie an estimation of the field with the arrival of new observations.If these methods perfectly fit the requirements of data assimilation, their weakness comes from their computational cost: the covariance matrix has to be computed and stored. The dimensionality of the most recent meteorological models (ECMWF) is around 6 millions of variables, it is clear that we are beyond the range of high performance computing (even if we extrapolate to the next generation of computers). Therefore most of the recent research has been devoted to reduced form of Kalman filtering.

Variational Methods: The basic idea is to consider the degrees of freedom of the model (initial and/or boundary conditions) as a control variable and to close the model through a variational principle giving the distance of a solution of the model to the observations. These methods use standard and robust algorithms of optimization. Tools, such as the adjoint model, are used which are also useful for other purposes such as sensitivity analysis. From the computational point of view, their high cost is decent especially if we consider the most recent generation of computers. These methods will become operational at NCEP (USA), Meteo-France, Météorologie Canadienne in a near future, they are operational at the

European Center for Medium Range Weather Forecast since October 1997.

Future Developments

A general framework of the research carried out in IDOPT is the improvement of numerical techniques used in the geosciences. The adaptive mesh method will be used in projects of operational oceanography. The efficiency of the data assimilation algorithms has to be improved: for the Kalman-type methods the size of the state should be decreased to make the computation realistic. The deterministic methods should be able to estimate the impact of uncertainties on the prediction; this can be done by adding some extra term modelling the error of model.. A major difficulty in the use of control methods comes from the necessity to use an adjoint model which permits to compute the gradient. The derivation of an adjoint model for very large numerical models (several hundred thousand statements) is a costly task in term of manpower. The use of tools of automatic differentiation, such as ODYSSEE (INRIA- Sophia Antipolis) could be a major progress for these methods.

Co-operation

The recent development of advanced techniques for the assimilation of data has been carried out through a fruitful co-operation between research groups in meteorology (LMD, LA, Meteo-France), oceanography (LEGI) and applied mathematics. This field of research is progressing both from the modelling of geophysical fluids and from the developing of the mathematics. Therefore a cooperation is more necessary than ever to achieve significant results. It is clear that the mathematicians cannot develop meteorological or oceanic models, neither can the geophysicists investigate the theory of deterministic or stochastic optimal control.

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Environmental Modelling at IACM-FORTH: Aiming at the Future

by Nikolaos Kampanis

Scientific computing at the Institute of Applied and Computational Mathematics (IACM) of FORTH has focused on the development of mathematical and numerical techniques for solving partial differential equations which describe various physical phenomena and technological processes, and on their computer implementation in user-friendly integrated systems supporting the pre- and post-processing of scientific computations, Graphical Information System applications, parallelization, visualization and decision making techniques.

Over the years a large amount of expertise has been developed on mathematical and computational methods for wave propagation problems, especially in the area of direct and inverse problems of underwater acoustics. For the direct problem several computational models for predicting the acoustic field in the sea have been developed and validated. The models are based on finite element and finite difference discretizations of the Helmholtz equation and its paraxial approximations and use state-of-the-art mesh generation and numerical linear algebra techniques. For the inverse problem several techniques have been proposed and tested for the purposes of identifying oceanographic and geoacoustic parameters. These techniques couple on site measurements and computational prediction models.

IACM is now in the process of expanding its involvement in environmental modelling. IACM is located in Heraklion, on the island of Crete in the southern part of Greece, an area whose economy is mainly based on local small-to-medium size industry, agriculture and tourism. The challenge of preserving environmental quality in the course of future development is of paramount importance. We intend to relate more of our research to the study of regional environmental problems and try to support the decision making processes and the regional planning of the local authorities, with which we have long established close cooperation.

There are several components of potential environmental modelling activities in Crete. One is the problem of the dispersion of water transported pollutants. For example, the disposal of fluid waste from local olive oil processing plants (Crete has a big olive production and provides significant quantities of processed olive oil to the domestic and international market) has to be treated efficiently, since it may be carried away by rain or rivers. Eutrophication phenomena due to the contamination of water basins by chemical fertilizers, and pollution of the sea, eg at the south of Crete where extensive areas are occupied by greenhouses, may destroy usable water supplies and the coastal zone. Other kinds of solid and fluid waste, due to the increase of the near-shore population and extensive tourist development very close to the coastline over decades of kilometres, are disposed in the sea. Hence, regional planning decisions need to be supported eg on the optimal location of industrial, touristic and other environment-affecting installations, especially when these are close to the coast. Therefore the study of coastal circulation, including local currents and surface motion, is important.

IACM currently participates in two projects related to water resources management. Both are in collaboration with INRIA, Rocquencourt, and scientists and institutions from several countries of North Africa and the Middle East. The first, funded by the Greek-French integrated action PLATON' 98 program, is the numerical simulation and prevention of water reservoir eutrophication. The other, funded by the European Union DGIII ESPRIT/INCO-DC program, has as its general theme flood modelling with use of HPCN and

GIS, and aims towards providing tools to support design of policies for a rational use of water supplies.

Due to its geographic position and regional climate conditions, Crete has long periods of strong north and south winds, which in some places are reinforced by complex mountain terrain. Hence, of major importance is the exploitation of wind and water wave energy resources, and Crete has been characterized by the Greek government as a privileged region for development and use of renewable energy sources. Not less important is the exploitation of solar energy due to the very long cloudless periods. Installation of wind farms is advancing at several places in Crete and the collection of field measurements and short-term weather forecasting will be of major importance for their optimal operational deployment. Agriculture will also benefit from such activities, that will also aid in the controlled and localized use of pesticides.

All this leads us to the conclusion that the monitoring of the atmospheric boundary layer inland and at coastal zones, as well as the simulation and forecasting of athmospheric flows on a regional basis using computational models will be very important. IACM has taken several steps to establish collaboration with scientists in Europe and in the US for these purposes. ■

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Implementing a High Resolution Numerical Model of the Strait of Gibraltar

by Gianmaria Sannino, Roberto Conversano and Vincenzo Artale

The Mediterranean sea is a basin in which a wide range of oceanic processes and interactions of global interest occur. Intense evaporation over the Mediterranean Sea produces dense, salty water that outflows through the Strait of Gibraltar and can have an impact on the general circulation of the global ocean and particularly on the formation of deep water in the North Atlantic. One effect of the outflow from the Mediterranean is to make the Atlantic Ocean saltier than either the Pacific or Indian Oceans.

The Gibraltar Strait controls the entire fresh water budget of the Mediterranean sea and for this reason there has been both experimental and theoretical interest in the physics of the Strait and on monitoring the heat and flux on the sill. The existence of this strait makes the Mediterranean sea one of the few regions in the world's oceans where the advective heat and salt flow is known with sufficient accuracy to permit testing of the available data sets, the bulk formula and the model results of the surface heat flux. In recent years, in the context of the III and IV Framework, the European Community has financed a number of projects aimed at improving knowledge of the Mediterranean circulation from both numerical and experimental points of view.

In particular, one task of the MTP-II-MAST Programme (1996-1999) is dealing with the numerical implementation of a high resolution numerical model of the Strait of Gibraltar and its parameterization in the Ocean General Circulation Model.

Motivations

Since the beginning of the century the Strait of Gibraltar has been a favourite place for oceanographic studies. The dominant oceanographic feature of the Strait is a two-layer inverse estuarine circulation that is driven by an excess of evaporation over precipitation and river discharge into the Mediterranean. In addition, recent field experiments in the Strait have kindled a renewed interest in two-layer hydraulics and its role in controlling the mass transport between the Mediterranean and the Atlantic sea.

As a result of the effects of this hydraulic control, two possible states have been hypothesised for the Mediterranean Sea/Strait of Gibraltar system: 1) over-mixed with maximal exchange, minimum difference in salinity between the two layers and a shallow, supercritical inflow at the eastern end of the Strait, or 2) not over-mixed, with sub-maximal exchange, a bigger salinity difference and a thicker sub-critical inflow.

The Alboran Sea Circulation is dominated by the Atlantic water entering the Alboran sub-basin as a shallow buoyant stream that curves southward most of the time. It then forms a large anticyclonic gyre, which may extend throughout the whole width of the sub-basin.

From satellite observations the gyre seems to have some variability, generating a second cyclonic gyre up to the main stream. The anti-cyclonic/cyclonic structure at the end of the Strait may be related to the geometry of the basin. Observations have also revealed the appearance of a second anticyclone in coincidence with the Almeria-Oran front. The variability of this second anti-cyclonic gyre is more pronounced than that observed in the western side of the basin. These two-three gyres are considered to be one of the permanent features of the Western Mediterranean circulation and participate in the formation of the MAW (Mediterranean Atlantic Water). The

precise criterion for the anti-cyclonic/cyclonic features of the Alboran sea are still unknown.

The numerical simulation that we show in the figures refers to the evolution of the Atlantic water into the Alboran basin and the outflow of the Mediterranean sea into the North Atlantic circulation. Figure 1 shows the Alboran gyre circulation and the Mediterranean outflow at depth. From a first analysis of these results we note a good agreement with the observations. However more experiments and analyses are needed to evaluate whether the resolution of the model is sufficient to describe this phenomena. In particular, we hope that our numerical experiments will answer a number of questions, such as:

- is there a permanent hydraulic control site in the Gibraltar Strait and, if so, how does it depend on seasonal variations in the Mediterranean basin?
- What are the principal forcing effects (tide, topography...) that can generate the variability of the ocean current along the coast of Portugal and the bifurcation of the Mediterranean outflow at Cape Saint Vincent?
- What are the physical mechanisms that generate gyre variability in the Alboran circulation?

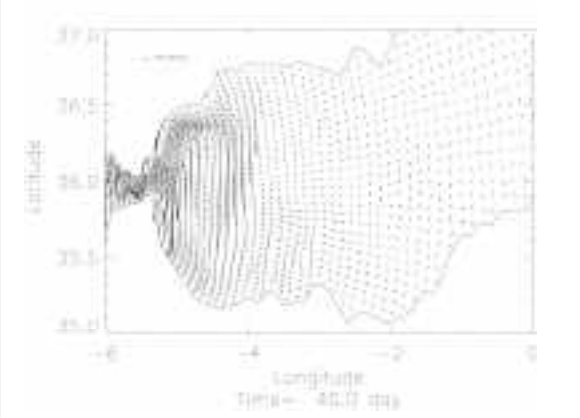

Figure 1: Velocity field of Atlantic inflow.

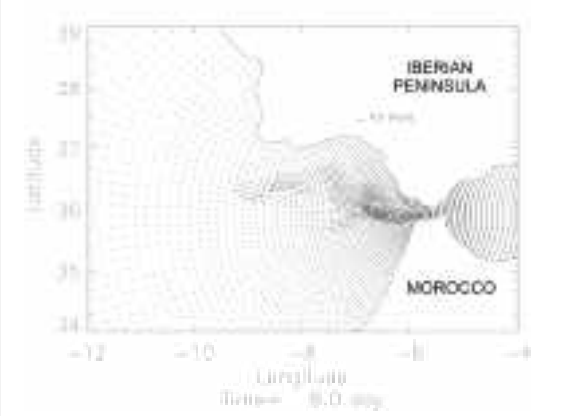

Figure 2: Velocity field of the Mediterranean outflow.

The numerical simulations were performed using POM (Princeton Oceanographic Model) a primitive equation numerical model. The model was initialized with climatological salinity and temperature without wind stress forcing. The boundary conditions are computed by the Newtonian relaxation terms at the boundary domains of the model using the monthly temperature and salinity climatological data. The model runs on the Digital 4100 parallel platform or on a CRAY J90.

For more information, see the project Web site: http//www.cetiis.fr/mtp/mater ■

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Water Quality Modelling in the Channel Network of Venice

by Lucia Zampato, Georg Umgiesser, Martina Bocci and Giovanni Coffaro

In Venice a new activity has started aimed at the hydrodynamic and water quality modelling of the city's inner channels. This project is considered to be important because of the problems the city of Venice has with pollution of its water and sediments. A two-dimensional finite element hydrodynamic model is used to simulate the behaviour of the lagoon surrounding the city; the modelling system WASP is used to describe the hydrodynamics of the inner channels and the quality of the water. A team of scientists from the Italian National Research Council (CNR) and the University of Padua carry out the modelling activity within the framework of the 'Inner Channels of Venice' Project, which begun in 1994. The project is coordinated by UNESCO's UVO-ROSTE Office in Venice and financed by the Italian Ministry for Scientific Research.

The city of Venice is uniquely structured, since it is constituted by small islands surrounded by a complicated network of channels that communicate with the lagoon. Even today, this channel system constitutes the principal way of communication for people, goods and public services.

These channels are also the collectors of pollutants; the most important of them are the sewage waters. Stopping the dredging of channels between the end of the 1960's and 1994 has worsened this problem and makes the pollution of water and sediments a very pressing problem for the city. Inquiry into the possible solutions to the problem of cleaning the channels is the general objective of the

project 'Inner Channels of Venice'. The concluding part of this project was started at the beginning of 1998 and is expected to terminate at the end of 1998.

Main research subjects in the project include:

a) the quality of water and sediments

b) the health of the inner channels

c) water quality modelling.

Topics a) and b) are performed through field measurements and laboratory analyses; they concern hydrodynamic quantities (velocity, water level), ecological parameters (temperature, salinity, pH, dissolved oxygen, nitrogen and phosphorus compounds and others), and biological indicators (virological parameters and pathogenic bacteria).

The activities in which the authors are directly involved regard the implementation of the water quality model (WASP) to the channel network of Venice. The possibility to simulate the hydrodynamic behaviour of the channels, and the evolution of biological parameters with different tidal regimes, meteorological conditions and morphological configurations, give an important contribution to this study. The research, co-ordinated by a team of international experts, is carried out in Venice by a group of local scientists.

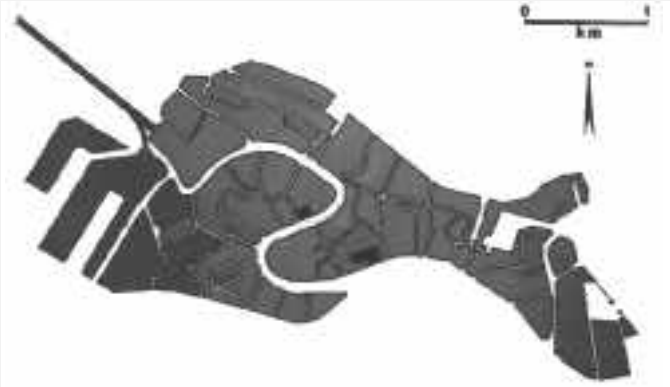

Figure 1: A map of the city of Venice with the main channels.

Figure 2: The channel network that has been adopted for the 1-D model.

Modelling Activities

The aim of the modelling activity is to obtain a description and therefore a better understanding of the hydrodynamic and eutrophic processes in the inner channels of the city of Venice. The activities planned are:

- the implementation of a 1-D hydrodynamic model to the channel network and its coupling with a 2-D hydrodynamic model for the lagoon of Venice, that provides the boundary conditions around the city
- the application of a water quality model to the inner channels.

To accomplish these tasks the following models will be used:

- a 2-D finite element model of the Venice Lagoon (Umgiesser, 1986): the grid of the model is made up of 4359 nodes and 7842 triangular elements describing the varying bathymetry. Forcing functions of the model are height of sea level at the three lagoon inlets, wind blowing over the lagoon and the discharges from rivers into the lagoon. The grid of the model will be modified in the area around Venice to allow the coupling with the 1-D model of the inner channels.
- The WASP-EPA model will be used to simulate water circulation and water quality of the channel network. DYNHYD, the hydrodynamic module of WASP, will be used to describe the water circulation; the model is based on a link-node approach and provides water velocity and waterlevel values. The model will be calibrated by means of the Manning coefficient with data on water level and velocity recorded during the field campaigns. The results of DYNHYD will be used in simulating the water quality. EUTRO, the water quality module of WASP, will be used to model the dynamics of the following water quality parameters: dissolved oxygen; organic carbon; nitrogen (as nitrate and ammonia); phosphorus (ortho-phosphate); chlorophyll-a; and suspended matter (modelled by means of the TOXI sub-model). Nitrogen, phosphorus, and suspended matter loading in the channels will be computed from data on the resident population and tourists and from water consumption data and specific conversion factors. Boundary conditions for the water quality will be extracted from the available water quality data in the area of the lagoon surrounding Venice. Initial conditions will be set according to field data gathered in the framework of this project and considering other data from the UNESCO database.

Conclusions

The model will be calibrated through the comparison with data already available, or collected in the field measurements during 1998. Future activities are planned in the framework of the project regarding the dredging of channels carried out by the municipality of Venice:modelling of hydrodynamics and water quality in the channels is an effective tool to better plan the excavation works and to predict the consequence of these on the water circulation and environmental health conditions. For further information, see: http://www.isdgm.ve.cnr.it/~georg/

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Numerical Algorithms for Air and Surface Water Quality Modelling

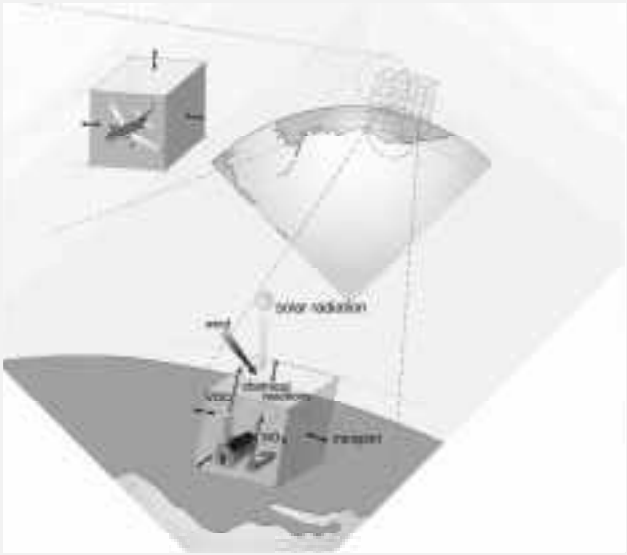
by Jan Verwer

Many environmental problems, such as damage to the biosphere, local air pollution, the spread of harmful substances in the water, and global climatic changes can not be studied by experimentation. Hence, mathematical models and computer simulations are being used as the appropriate means to get more insight. CWI has been active in this field from the early 1990s and co-operates with several organizations within and outside The Netherlands. Significant parts of the research are carried out within the TASC project (Transport Applications and Scientific Computing) and are supported by the national HPCN programme and the Cray University Research Grants Programme.

The mathematical models consist of a set of partial differential equations (PDEs) describing the system's evolution in time. By discretizing the time and space variables occurring in the PDEs on a grid, a numerical model is obtained, which is then solved on a computer. Due to the rapid progress in high performance computing this numerical approach is nowadays many times cheaper than building traditional scale models. In addition, many processes such as the spread of pollutants defy accurate simulation by means of scale models.

Solving such realistic time-dependent PDEs numerically is very computation-intensive. Discretization in space coordinates produces a formidable set of ordinary differential equations (ODEs) in which only time occurs as a continuous variable. This set of equations is then solved step-wise in time by means of a numerical integration formula. The choice of the spatial discretization and the integration formula depends on the stability of the evolution process, the desired accuracy of the approximation and the efficiency of the entire computation process.

CWI carries out research jointly with the national Organization for Applied Research TNO to develop a regional 3D long-term ozone simulation model, replacing the current LOTOS model used by TNO. CWI contributes with the design of the mathematical model for a hybrid (terrain following and pressure based) coordinate system and, in particular, of tailored numerical algorithms and implementations on parallel and super-computers.



The solution of realistic 3D models for atmospheric pollution, in the form of PDE's of the advection-diffusion-reaction type containing 20--100 chemical species, poses challenging computational and numerical problems. (Adapted from: Atmosphere, Climate & Change, by T.E. Graedel and P.J. Crutzen, Freeman & Co., 1995.)

In a similar project, CIRK, CWI has developed numerical algorithms for use in 3D models describing global changes in the troposphere's chemical composition due to the long-term spread of air polluting substances, taking into account exchange with the stratosphere. The work included stiff chemistry integration and a factorization approach within the Rosenbrock method, as well as the validation of various advection schemes in a real-life radon experiment, using analyzed wind fields from ECMWF. New work in this field centres around the existing TM3 model. Other recently started research in air quality modelling concerns application of operator splitting and sparse-grid methods to advection-diffusion-reaction problems.

CWI's present contributions to water quality modelling are based on a previously developed efficient computing model for 3D shallow-water equations (SWEM). Here a parallel vectorized flow model was implemented on a Cray supercomputer. In SWEM a transport model is coupled to a hydrodynamic model which generates the velocity field for the transport model. Starting from the SWEM model CWI designs parallel numerical methods for the simulation of water pollution (calamitous releases), the marine eco-system, dispersion of river water, sediment transport, etc. In connection with this a 3D transport model was studied, in particular the iterative solution of the equations resulting from their implicit time-discretization, and domain decomposition with domains of varying grid resolutions. Part of the research is carried out in the EU programme MAST within the MMARIE project (Modelling of Marine Eco Systems), with applications to pollution on the Continental Shelf caused by sediment transport from the Rhine and other major European rivers.

For more information see:

- http://dbs.cwi.nl/cwwwi/owa/cwwwi.print_projects?ID=2 (air)
- http://dbs.cwi.nl/cwwwi/owa/cwwwi.print_projects?ID=4 (water)

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Modelling of the Environmental Impact of Main Airborne Pollutants Producers

by František Hrdlička and Pavel Slavík

The vast part of electricity produced in the Czech Republic is produced in power stations where as a fuel the brown coal is used. This type of coal contains elements (like sulphur dioxide etc.) that have a very negative impact on the environment. During smog alert situations it is necessary to reduce emissions from power stations to an acceptable level either by lowering output of power stations in the region or by usage of high quality coal in some power stations.

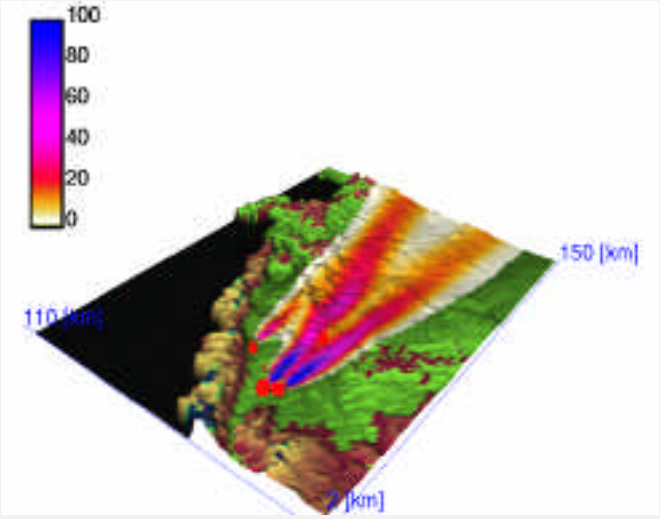
The question which power stations should be regulated is a very critical one. Such a decision is based on the data from the network of monitoring stations that monitor pollution and from data obtained from the national meteorological institute.

The problem is that these data are not interpreted in a wide context what leads to situations when it is impossible to determine the power station that has the largest contribution to the level of pollution in the critical area. The solution to this problem is to develop a mathematical model that can simulate the distribution of pollutants in a given region under certain meteorological conditions. In such a way it is possible to determine the contribution to pollution in the investigated (critical) area for each single power station. Thus it will be possible to determine the power station with the largest impact and the corresponding measures can be taken (either to lower output or to switch to higher quality coal). In such a context it is possible to optimize the output lowering process as this process has besides ecological criteria also economic ones. Therefore a software system has been developed that describes the emission distribution in the atmosphere. The mathematical model used is based on the statistical theory of diffusion – namely Briggs and Giffords theory of diffusion. This theory belongs to the class of theories called Gaussian models as the distribution of gas concentration is controlled by the properly modified Gaussian distribution.

The model discussed has been implemented by means of the IRIS Explorer system on Silicon Graphics computers. An important problem to be solved was the userfriendliness of the system. The results of simulation have a form of a map with colour representation of the pollution level. The input has also graphical form where by means of direct manipulation techniques the input values are set. This concerns for example the settings of parameters for each single power station or setting the meteorological conditions in the region. It is also possible to click on any location on the map and the information about the current level of pollution together with share of each single power station in a graphical form is displayed. Moreover it is possible to set parameters that define an animation sequence that represents dynamical change of some parameters of the process investigated.

The model has been evaluated by means of comparison of simulated data and a real data. The real data were influenced by other sources of pollution than power stations investigated what had impact on the match between the model and reality. Nevertheless there was a good match from the point of influence of each single power station on the level of pollution in the region investigated.

The system developed is a pilot system for the given application. There is a lot of potential for further development. Future work could lead to the development of a model where the data obtained from the network of monitoring stations can be interpreted by means of information obtained from the model developed. It could be possible to employ methods of artificial intelligence that will support learning process of the system that could help to eliminate the influence of local sources of pollution. The model developed could be also used for simulation of gas distribution during ecological disasters like accidents in chemical plants or in nuclear power stations. It could be possible to model and evaluate various measures that could be taken in the case of disaster.



Visualization of air pollution caused by three power stations.

■

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Dynamic Models for Smog Analysis

by Achim Sydow, Thomas Lux, Peter Mieth, Matthias Schmidt and Steffen Unger

The project DYMOS (Dynamic Models for Smog Analysis) carried out at GMD Institute for Computer Architecture and Software Technology, Berlin, is concerned with the development and pilot application of simulation systems and models for air pollution and vehicular traffic, running on High Performance Computing platforms. The aim is to support users in governmental administrations and industry in operative decision making as well as long-term planning, to serve as a scientific basis for national or international negotiations, and to enable predictions (air pollutants concentration, traffic density, etc.) for informing the public (WWW, TV, radio).

The DYMOS system is a parallelly implemented air pollution simulation system for mesoscale applications. DYMOS consists of different meteorology/transport models for different application purposes including an air chemistry model for the calculation of photochemical oxidants like ozone.

The core of the model system is formed by a hydrostatic mesoscale Eulerian model with a low vertical resolution for fast operational forecast tasks (enhanced version of REWIMET/REgional WInd Model Encompassing Transport) and a non-hydrostatic mesoscale Eulerian model with a high vertical resolution and complex parameterization facilities (enhanced version of GESIMA/ GEesthacht SImulation Model of the Atmosphere). In addition, some Eulerian and Lagrangian transport models are included within DYMOS. The air chemistry model CBM-IV (Carbon Bond Mechanism) is dealing with 34 species in 82 reaction equations for simulating the photochemical processes in the lower atmosphere.

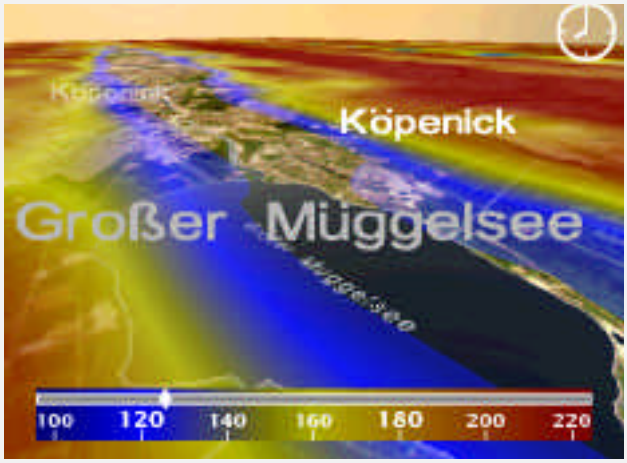
Using the DYMOS system, analyses can be performed regarding winter smog (high concentrations of inert pollutants), summer smog (high concentrations of ozone and other photochemical oxidants), and single components (eg heavy metals, benzol, radioactive or antigenic substances). In addition to providing a dynamic emission source for the smog forecast simulations, traffic flow modelling has become a research field within DYMOS in its own right. Emphasis is put on the analysis of critical states in urban traffic systems. Due to the research work with basic character carried out in DYMOS, a foundation has been set for further, more applied projects.

DYMOS Applications

Various case studies of summer smog conditions in urban areas have been carried out using the DYMOS system. The Department of the Environment of the Berlin state government and the Ministry for Environment of the state Brandenburg commissioned summer smog analyses for the results of a measuring campaign carried out in July 1994. Greenpeace commissioned an analysis of the influence of emissions caused by traffic in Munich on the ozone concentration in the Munich area. The analysis was performed for a typical mid-summer day in 1994. Within the subproject PATRIC (Parallel Petri-Net Simulation for Traffic Control in Conurbations) the DYMOS system coupled with an Petri-net-based traffic flow model was used to analyze the traffic induced air pollution of the City of Budapest.

In order to inform the public about ozone concentrations, the DYMOS system is currently in its test phase for the operational daily forecast of near surface ozone concentrations in the Berlin-Brandenburg region. In cooperation with the Department of the Environment of the Berlin state government, the German Federal Environmental Agency and Inforadio Berlin, the predicted concentrations are presented as raster images for defined day times and as MPEG movie (see figure) for the whole day and can be found on the WWW (http://www.first.gmd.de/ozon/).

The research activities within DYMOS have given rise to a number of direct subprojects and three autonomous European cooperation projects based on DYMOS: ECOSIM/ Ecological and environmental monitoring and simulation system for management decision support in urban areas (see page 22), HITERM/High-Performance Computing and Networking for Technological and Environmental Risk Management (see page 26) and SIMTRAP/HPCN Simulation of Traffic Induced Air Pollution Using Parallel Computing in a Distributed Network (see page 27). More information about the DYMOS project is available at http://www.first.gmd.de/applications/proj/dymos_more.html ■



Snapshot of a movie for the dynamic visualisation (helicopter flight) of near-surface ozone concentrations in the Berlin region.

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Development of an Integrated Environmental Monitoring and Simulation System

by Peter Mieth, Matthias L. Jugel, Steffen Unger and Bertram Walter

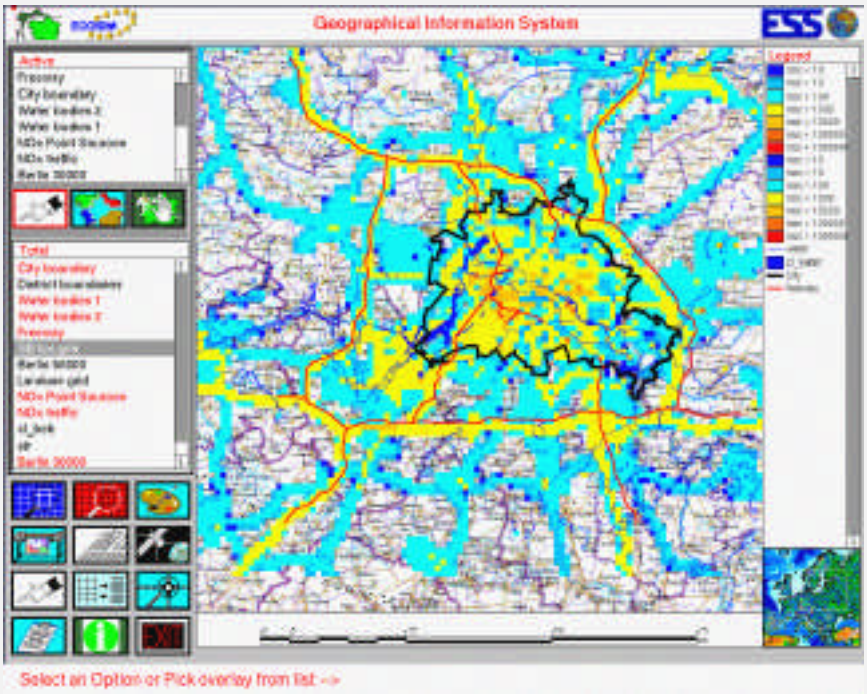
The project ECOSIM (Ecological and environmental monitoring and simulation system for management decision support in urban areas) will provide a prototype for an integrated environmental monitoring and simulation system. It integrates, through a distributed client/server architecture data acquisition from an on-site environmental monitoring network, data analysis and visualization tools, a range of numerical simulation models of different complexity to assess the air, the marine water and groundwater quality after releases of pollutants, and an embedded expert system. ECOSIM is a European cooperation project funded by the European Commission within the Telematics Applications Programme.

The ECOSIM system builds on a set of sophisticated state-of-the-art simulation models (eg air chemistry models). It exploits existing knowledge in environmental management by connecting these models with an advanced Geographical Information System (GIS), on-line monitoring networks, local databases, and an embedded expert system.

This allows eg a direct link between the models, up to-date measurements of current meteorological conditions, and actual pollutant background concentrations. ECOSIM is also able to consider different environmental domains such as air, surface water, and coastal water to ensure an analysis as complete as possible.

The following simulation models are presently implemented into the ECOSIM system:

- the non-hydrostatic, prognostic, grid-based, (Eulerian) mesoscale 3D windfield model MEMO
- the dispersion and air chemistry part of the DYMOS system (Dynamic Models for Smog Analysis), responsible for the advective transport, turbulent diffusion and surface uptake of the air pollutants



ECOSIM user interface.

- the mesoscale ozone forecast model REGOZON
- the modular, finite-difference based 3D ground water model MODFLOW-96
- the prognostic 3D ocean model POM, responsible for the temperature-, velocity-, and salinity distribution in shallow water as well as in deep ocean domains.

The ECOSIM system integrates data acquisition and monitoring systems, GIS, and dynamic simulation models in a flexible client-server architecture. In general, the different model components run at different locations on different computers. They are connected via Internet and controlled by a main server located at the user's office. The simulation results can be visualized on the server as well as on any remote client's platform.

ECOSIM Applications

Besides GMD Institute for Computer Architecture and Software Technology, Berlin, ECOSIM involves participants from Austria, Greece, Italy and Poland. ECOSIM will be developed and tested in close collaboration with three city authorities with differing environmental problems and state-of-the-art approaches to environmental management. ECOSIM will be used within the city of Berlin, Germany, to provide an improved method for modelling the level of ozone which depends mainly on traffic emissions.

For the city of Athens, Greece, similar problems will be addressed as well as the interplay between surface and ground water and coastal pollution. ECOSIM will also be applied in a more limited manner in the city of Gdansk, Poland.

More information about ECOSIM is available at http://www.first.gmd.de/applications/proj/ecosim_more.html ■

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Air Quality Modelling for the Madrid Region

by Roberto San José

The Environmental Software and Modelling Group of the Computer Science School of the Universidad Politecnica de Madrid (UPM) is conducting reseach in the field of Air Quality Modelling. The main modelling research activity is focused on the development of prognostic air quality models which include different modules. The final purpose is to develop a research code which is able to forecast the three dimensional air concentrations over urban and regional environments in short range, one to seven days.

The integrated air quality modelling system (ANA) will include high quality land use classification, detailed anthropogenic and biogenic emission over the test domain, high resolution altitude values, meteorological external information for boundary conditions, initial meteorological soundings, initial surface pollution information, use of updated meteorological and pollution information in on-line mode.

To date, the group has developed an operational version of the ANA model which is called EMMA. This work is carried out in the frame of the EMMA project supported by the European Union Telematics Applications Programme.

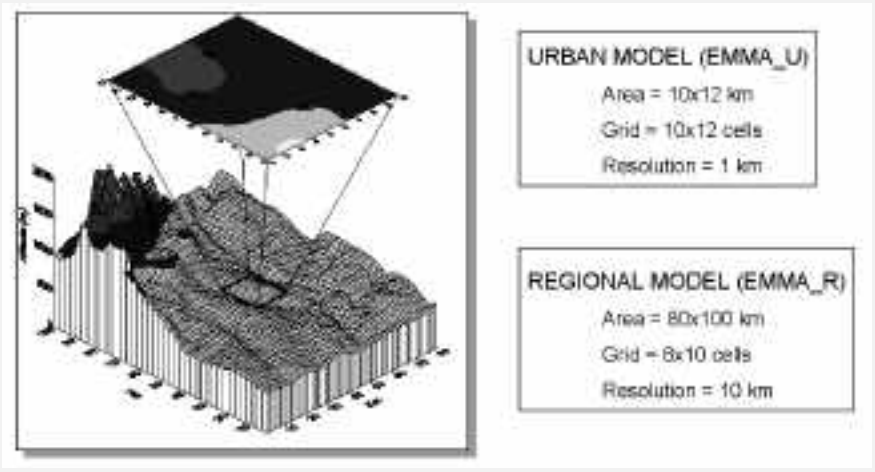
The EMMA model includes the EMMA-R part which forecasts the primary and secondary pollutants on the region where the urban area is included and the EMMA-U part which includes a high spatial and temporal resolution model for the urban area. Both models are running simultaneously. The EMMA-U model requires the information from the EMMA-R. This version of EMMA is the so-called nested EMMA model. A test version of the EMMA model is used by the Madrid Community and Madrid City Council since 1997.

The group is also involved in different DGXII projects of the European Union which include complex and extensive field campaigns. These campaigns have been carried out in the Madrid Community and they focused on the determination of the SO_2, NO_X, NH_3 and O_3 deposition fluxes. The NH_3 Amanda gradient system allows the determination of bi-directional net emission/deposition fluxes. The O_3 fast ozone sonde and the sonic anemometer allows to measure directly the eddy correlation fluxes. The rest of the instrumentation applies the indirect gradient method for measuring the net deposition fluxes.

Nowadays projects are focused on the embedding of satellite data, surface meteorological information, meteorological soundings and regional and metropolitan air monitoring networks on the 'spin-off' period of the prognostic air quality models such as ANA or EMMA. The importance of the data assimilation module has been clearly stated in many different scientific contributions in the past. The group is intensively working on this important part in order to improve significantly the predictions.

The group is particularly interested in the operational versions of the air quality models (ANA, EMMA, etc.) by using the information provided by those instruments (satellites, sounding, pollution networks, etc.). The ACS (Analysis Correction Scheme from the U.K. Meteorological office) scheme is on the way to be incorporated to the model system. In addition, the MM5 model (PSU/NCAR) is also in use in the laboratory. The advantage of using a combined version of MM5/ANA-EMMA are clear since the period that the model should be run in order to produce 24-48 hour forecasts are between 120-168 hours.

The needs of having meteorological information from areas on about 2000 km away from the domain where the air quality model is run are completely cover by using this combined version since ANA is not applicable over domain greater than 400-500 km. This version should be operative at the end of this year. In addition, the laboratory is working with the Urban Airshed Model (UAM) from EPA (Environmental Protection Agency, USA) which is intended to be linked to the MM5 to carry our simulations over Europe and to produce proper boundary conditions for ANA model.
Also, the Laboratory has developed a Lagrangian Particle Model (LAGMO) which should be used to predict the particulate matter over urban and regional domains and should be incorporated to the ANA system in the near future. Finally, the laboratory is incorporating to ANA air quality system a Gaussian model based on the ISCT3 (EPA, USA). The user - through the tcl/tk visualization system - will be able to select the type of simulation he prefers and for specific domains, it would be possible to run



EMMA Domain Topography.

several thousands of gaussian models which will produce detailed maps over the sub-grid scale (Eulerian approach) for traffic or industrial applications. Also, the user would be able to select the LAGMO model for selected sub-grids.

The possibility of having a detailed prediction over very fine areas (by using the LAGMO and GAUSSMO models for this specific areas) is an important advance of this type of models. Finally, the WWW capabilities are being integrated into the ANA air quality system to use nowadays meteorological on-line data on quasi-real-time processes. ■

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Computing the Radiative Balance in Mountainous Areas: Modelling, Simulation and Visualization

by Jean-Luc Borel, Yves Durand, François Sillion and Christophe Le Gal

In mountain climatology and plant ecology, the estimation of the thermic action of the relief and the calculation of the radiative budget of the slopes constitute an inevitable prerequisite stage. Two image synthesis techniques have been used for the computation of the radiative balance in mountainous areas, namely the painter's algorithm and the radiosity model,. This approach allows to take into account, on a fine scale, the complexity of the interactions between the incident solar radiation (direct but also diffuse) on the one hand and and the local topography on the other hand.

The research project presented hereunder is in keeping with the development of a high-resolution regional climate model. One of the main aims lies in the characterization and the quantification of the influence on the interface fluxes of the land surface properties, more especially those bound to the vegetation cover (albedo, roughness length, emissivity, evapotranspiration, ...). Nevertheless, in mountainous areas, altitude, aspect and slope greatly influence all the climatic parameters. Mountains, owing to the obstacle put to the solar radiation, may significantly modify the energy fluxes. Two problems have been tackled, first the impact on the direct solar radiation of the shadowing induced by a topographic mask effect and resulting in a so-called cast shadow, then the reflexion phenomena between opposite mountain sides, all particularly when the ground has a high albedo, for example when it is covered with snow (figure 1).

From a methodological point of view, noting that the distribution of light energy is one of the most frequently addressed problems in image synthesis, the exploration of the possibilities afforded by the techniques classically used in this scientific field has deliberately been chosen. This approach is therefore rather different from the topographically based solar radiation models already available. This research project has induced a transdisciplinary collaboration between a plant ecologist, a mountain climate specialist and an image synthesis specialist. The research work have been carried out in the frame of an university degree (DEA IVR, INPG-UJF, Grenoble) by a computing engineer during the last year.

The Cluses-Chamonix area, in the northern part of the French Western Alps (Haute Savoie) has been chosen as study area (55,5km x 20km). The spatial resolution of the digital elevation model (DEM) for this study area is 75m x 75m. Relating to the meteorological data, a data base has been set up for this study area with the output values of the SAFRAN analysis system, a numerical tool developed by the Centre d'Etudes de la Neige of Météo France. SAFRAN provides, since the 1st August 1981, an hourly estimation, above the ground surface, of the values of nine meteorological parameters for each 300m altitudinal section and for seven aspects; so, for example, concerning the incoming shortwave solar radiation, its two components : the direct incident solar radiation and the diffuse incident solar radiation. Considering the key role played by the snow on the distribution, composition and structure of the different vegetation communities in mountainous areas at mid and high altitudes, a physically-based snow cover simulation model has been developed. By another way, snow cover presents a high sensitivity to climate variations. This sensitivity to changes within the radiative budget has been used as to test the efficiency of the various algorithms selected. The computation of the radiative budget in each point of a mountain massif slope requires first at all to take into account the impact of the topographic masks and of the cast shadows induced by the surrounding relief on the direct incident solar radiation. The different available algorithms (ray tracing, ray casting, floating horizon, Z-buffer and painter's algorithm) have been systematically tested according to several criteria such as, for example, computer capacities, computing costs and display possibilities.

A preliminary study performed with a classical ray tracing method for a day chosen at random (9 March 1985) shows that the shadowing may cause a reduction of the received direct incident radiation ranging between 20 to 60 %! Now, owing to its small cost, the computation and the visualization of the interception by the surrounding relief of the direct incident solar radiation is performed with the so-called inverted version of the painter's algorithm. The painter's algorithm is a depth-sort algorithm which allows to display the polygons in order of the decreasing distance with regard to the observer, from back to front. After implementation of the inverted painter's algorithm (increasing distance from the viewpoint), a simulation of a yearly cycle, namely 1990, has been performed. It follows that the integration of the orographic effects in the computation of

the radiative balance in mountainous regions may involve, in shaded areas, the appearance and/or the conservation of a snow cover. The impact of cast shadows on the space-time variability of the snow cover clearly appears at low and middle altitudes, their influence at high altitude remaining generally small. These consequences are illustrated by a simulation of the snow cover state for the Cluses-Chamonix study area on the 18 January 1990 at 12.00 (figure 2)

For the computation of the reflection phenomena between opposite mountain sides, the radiosity method has been used. The radiosity models are derived from the thermal models and are based on the notion of global energetic balance by taking into account the incident light energy, the scattered light energy and the absorbed light energy. They provide an accurate treatment of the light reflections

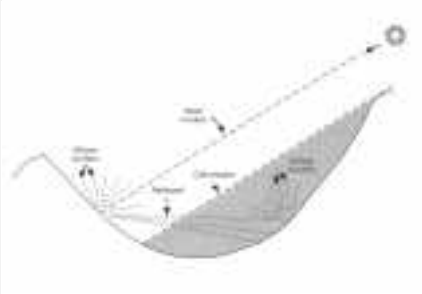

Figure 1: Topographic effects on solar radiation fluxes.

between objects in a view-independent way. These algorithms are based on the conservation of the light energy in a closed environment. The use of the radiosity equation is based on the computing of the form factors between surfaces. The form factors may be defined as a coefficient of geometric coupling. In a first time, so as to estimate the possible energy exchanges, a simplified scale model of an encased valley chosen in the south-eastern part of the Cluses-Chamonix study area has been created. After computation of the form factors between the two opposite mountain slopes, the simulation shows that the taking into account of the energy exchange within mountain sides may increase the amount of the energy balance by about 40 % for ground without snow and even up to 150 % for a snow-covered ground ! The results of the simulation for the 18 January 1990 at 12.00 are shown in figure 3. At last, incidentally, the knowledge of the form factors and consequently of the visible sky proportion for each facet, the so-called sky-view factor, equally allows to evaluate the interception by the relief of the diffuse incident irradiance. The differences, positive and negative, involved by the integration of the relief effects on the computation of the radiative balance for the study area are summarized in the figure 4.

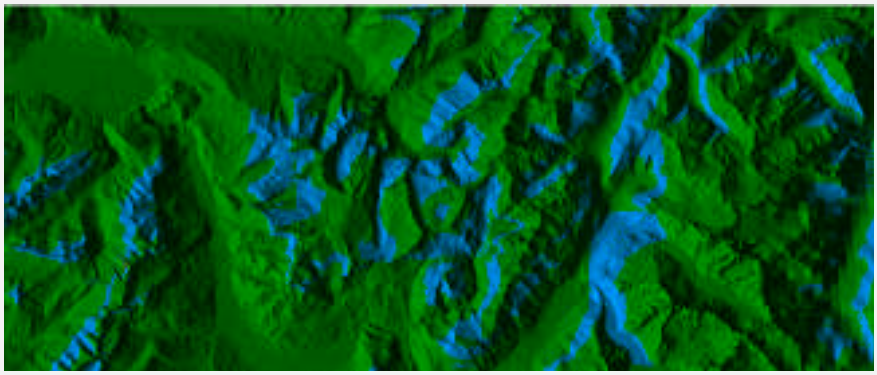

Figure 2: Simulation of the state of snow cover for the Cluses-Chamonix study area on 18 January 1990 at 12.00 including shadowing; in white areas shaded, with a "snow gain".

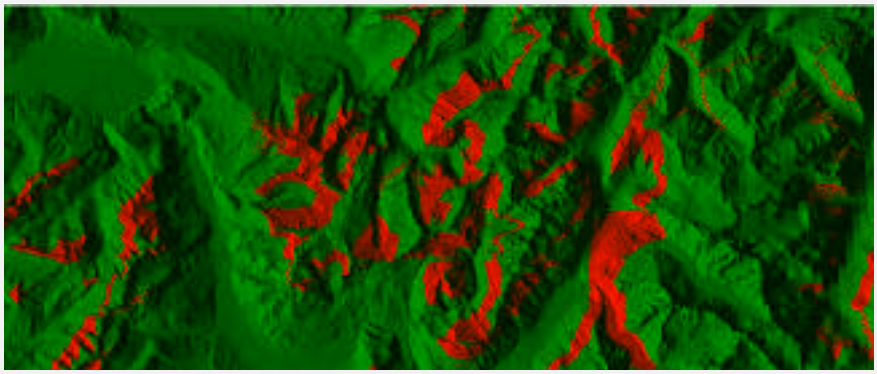

Figure 3: Simulation of the state of snow cover for the Cluses-Chamonix study area on 18 January 1990 at 12.00 including shadowing and energy exchanges between opposite slopes; in black, areas with a "snow loss".

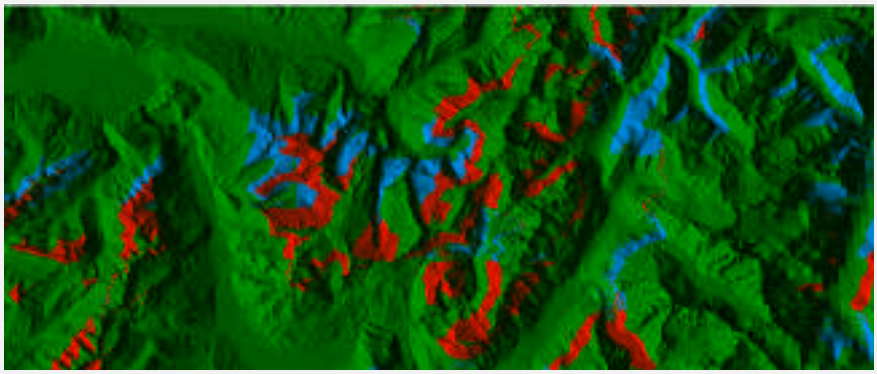

Figure 4: Simulation of the state of the snow cover for the Cluses-Chamonix study area on 18 January 1990 at 12.00 including shadowing and energy exchanges between opposite slopes; in white, areas shaded, with a "snow gain", in black, areas with a "snow loss".

The main purpose of this research project was methodological. So as to assess as accurately as possible the impact of the topography on the radiative budget in mountainous areas, it seemed interesting

to explore the possibilities afforded by the techniques used in image synthesis. It was then advisable to establish the relevance and to test the efficiency of the various proposed algorithms. The numerous simulations and visualizations performed for the Cluses-Chamonix study area with the digital elevation model and the snow model did not show obvious errors or inconsistencies. This preliminary research was a first stage of prime necessity. The short-term goal lies in the integration of the shadowing model in a high-resolution regional climate model so as to estimate more precisely the amount of direct irradiance for each surface location (pixel or groups of pixels) then, at middle term, the integration of the radiosity model for the calculation of the energy exchanges between opposite slopes. Simultaneously, complementary simulations will be performed so as to characterize the impact of the topography on the duration and on the intensity of the direct radiation fluxes according to the different aspects and according to many time scales (diurnal cycle, seasonal cycle, ...). ■

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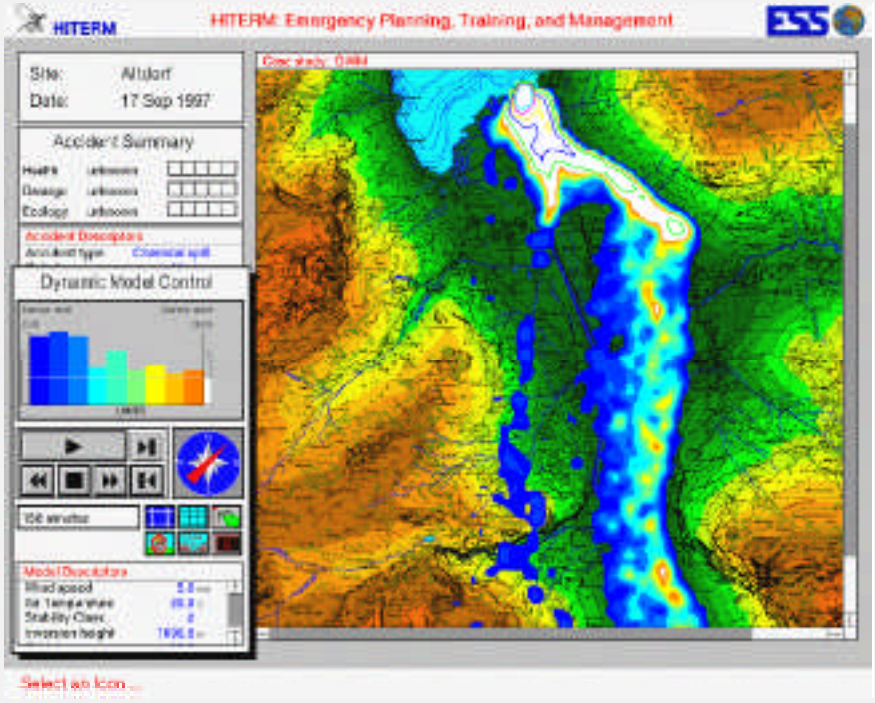
Environmental Risk Management

by Steffen Unger, Irene Gerharz, Matthias L. Jugel, Peter Mieth and Susanne Wottrich

Within the project HITERM (High-Performance Computing and Networking for Technological and Environmental Risk Management), a new generation of interactive risk assessment and management systems is being developed. Based on HPCN, the system will contain tools for the simulation of the accidental release of hazardous substances and the adaptive routing of hazardous transports. HITERM is a European co-operation project funded by the European Commission within the ESPRIT Programme.

The aim of the HITERM project is to reach better-than real time performance for the simulation of the accidental release of hazardous substances into the atmosphere, ground, or surface water. The developed HITERM system will support the user in the field of emergency management, emergency planning, and emergency training, both for transportation accidents and (Seveso-class) chemical process and storage plant accidents. Integrating environmental risk criteria and road information, the system will be able to simulate accident scenarios along the preferred and a number of alternative routes, and to determine the optimal routing (dynamic adaptive routing).

The simulation system HITERM is designed to meet the increasing demand for real-time information in environmental risk management. It can be used as a decision tool or as training tool, simulating and analysing differing risk scenarios and therefore improving the efficiency of any emergency planning. Moreover, the dynamic routing of hazardous goods provides an additional safety feature to the environment.



HITERM user interface.

The HITERM System

The HITERM system is based on a distributed client-server architecture, using standard http protocols. It contains:

- real-time data acquisition systems such as transport telematic systems, satellite imagery, weather radar, observation stations including hand-held data acquisition systems, and video input

- HPCN simulation models, eg atmospheric dispersion models
- specialised expertise in form of multi-criteria optimization systems, rule-based expert systems, or neural nets
- multi-media clients, including local and networked X Windows servers, http clients, mobile clients and hand-held computers.

As the amount of information generated by the simulation system is considerable, its visualization tools are based on sophisticated HPC methods.

Uncertainty Analysis

The field of environmental modelling involves considerable uncertainties, both in terms of model and parameter uncertainty, as well as concerning the input data. For that reason, sensitivity and uncertainty strategies in form of Monte-Carlo methods or methods based on Automatic Differentiation have to be integrated into the system.

HITERM Applications

Besides GMD Institute for Computer Architecture and Software Technology, Berlin, HITERM involves participants from Austria, Italy, Portugal and Switzerland. Among the planned case studies to test and demonstrate the capacities of the system are:

- dynamic adaptive routing (Portugal): transportation of hazardous cargo (petrol and diesel) by a vehicle fleet
- transportation accident simulation (Gotthard alpine corridor, Swiss): release of a hazardous substance into the atmosphere or into the ground water
- process plant accident (Region of Ponte San Pietro, Northern Italy): leeking or spilling of toxic or flammable substances into the environment.

More information about the HITERM project is available at http://www.first.gmd.de/applications/proj/hiterm_more.html

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Integrated Traffic and Air Quality Simulation

by Matthias Schmidt, Birgit Kwella, Heiko Lehmann, Christian Motschke and Ralf-Peter Schäfer

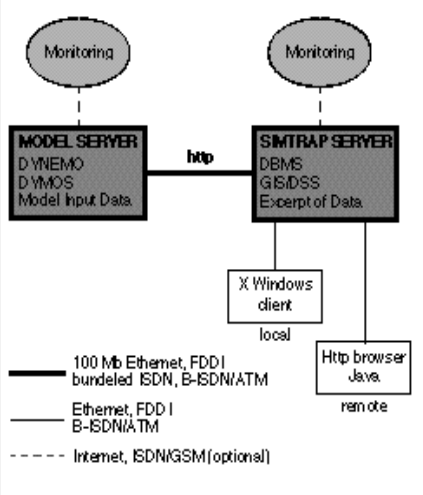
The aim of the project SIMTRAP (HPCN Simulation of Traffic Induced Air Pollution Using Parallel Computing in a Distributed Network) is to create an integrated simulation system for modelling both the traffic and the air quality, particularly for medium term planning. The system will be able to address most issues of the transport-environment link, such as traffic volumes, demand profile, and fleet composition from the traffic point of view, and (industrial) sources of pollutants, orography of the model area, land use, and meteorological conditions from the air pollution side. SIMTRAP is a European cooperation project funded by the European Commission within the ESPRIT Programme.

The link between vehicular traffic and air pollution is well established. For example, road traffic accounts for more than 70% of the overall nitrogen oxides and more than 55% of the overall volatile organic compounds emission in the Berlin region. For this reason, authorities in urban areas need support in managing road traffic so as to avoid exceeding pollution limits during hot summer periods. To date, much of the past modelling work concerning transport and air pollution has concentrated on long term strategies, where the effects on air quality indirectly may be expressed through energy use and emission reduction.

The increasing demand on the travel system and the tightening of many environmental standards, however, require to focus more on developing medium term strategies, eg on strategies during the closure of streets due to adverse meteorological conditions or severe reconstructions, or the guidance during special events. For developing medium term strategies, the demand on integration between the traffic models and the air quality models is the highest. Integrated dynamic tools are required to assess alternative strategies, and to select the most appropriate one.

The SIMTRAP System

SIMTRAP centres around two well-established core components: the mesoscopic dynamic traffic model DYNEMO (Dynamic Net Model) and the air pollution model system DYMOS (Dynamic Models for Smog Analysis).



SIMTRAP System Structure.

Due to the complexity of the simulated processes, both modules are being implemented in a remote HPCN environment. The simulation results will be visualized in a local 3D Geographical Information System with built-in functionality for decision support. Communication is realized using existing computer networks and standard protocols.

The Models Used in SIMTRAP

DYNEMO is a simulation tool for both urban and rural road networks. It has already been used to simulate large parts of the German motorway network.

Regarding the movement of vehicles, DYNEMO is a mesoscopic model in the sense that it combines properties of both microscopic and macroscopic models. As in microscopic models, the unit of traffic flow is the individual vehicle. Their movement, however, follows the approach of macroscopic models and is governed by the average traffic density on the link the vehicles travel.

DYMOS is a simulation system to analyse the generation, dispersion, and chemical transformation of gaseous air pollutants and different aerosols. The model is well suited to reproduce most frequent occurring kind of smog situations, in particular summer smog which is mainly caused by traffic emissions.

SIMTRAP Applications

Besides GMD Institute for Computer Architecture and Software Technology, Berlin, SIMTRAP involves participants from Austria, Italy and the Netherlands. In order to demonstrate the functionality of the system and to validate the obtained simulation results, the SIMTRAP prototype will be applied by potential users at the four tests: Berlin, Vienna, Milan and the Ranstaad area in the Netherlands.

All test sites differ considerably in size, geographical realities, and considered traffic network, and therefore are well suited to test the complexity of the SIMTRAP system.

More information about the HITERM project is available at http://www.first.gmd.de/applications/proj/hiterm_more.html ■

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Land Use and Wind Estimation as Inputs for Air Pollution Modelling

by Dominique Bereziat, Jean-Paul Berroir, Sonia Bouzidi, Isabelle Herlin and Hussein Yahia

This presentation investigates the use of remote sensing image processing techniques to estimate input data for air quality models. These models actually use a lot of input data, whose collection can be inaccurate or costly. Thanks to their high spatial and temporal resolutions and their rich spectral content, remote sensing data can be analysed to estimate some input data in an objective and accurate way. This research is led at INRIA (AIR project) in collaboration with GMD Institute for Computer Architecture and Software Technology (FIRST), Berlin within the ERCIM working group Environmental Modelling.

Air quality models require a lot of different input data. The collection of this data can be inaccurate or costly and is one of the major limitations to the operational use of air quality models. Remote sensing data have a great potential to enhance input data collection thanks to their high spatial and temporal resolutions and rich spectral content. Remote sensing data can be analysed to estimate input data in an objective and accurate way.

Input data required by air quality models can be classified into three main branches:

- site documentation data give information about the site's orography and land use; remote sensing techniques can be used to produce these data automatically, thus making the adaptation of a model to a new site easier
- model initialisation, boundary conditions and synoptic data include cloud cover, wind profiles, soil temperature; these data have to be known very accurately when running a forecast or a simulation; they are however estimated from a sparse net of ground stations, and the use of remote sensing data for their estimation has not been evaluated yet
- model parameterisation data include the values of the various physical parameters involved in air quality modelling, for instance surface characteristics (temperature diffusivity, emissivity, albedo, aerodynamic roughness length). These parameters are most often assigned a constant value according to the land cover, regardless of seasonal changes and spatial variability. Here again, satellite data can be used to achieve an objective parameter estimation.

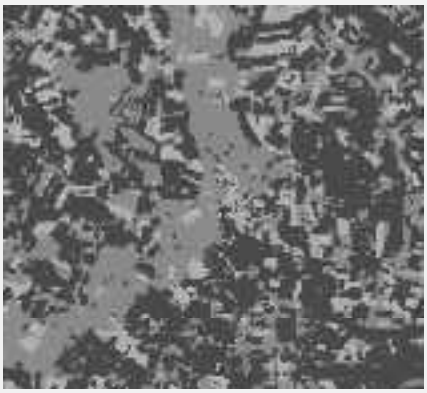

Figure 1: Example of land use identification on the basis of its temporal behavior.

In the following, we briefly detail three examples showing the ability of image processing techniques to estimate input data for air quality models: land use spatio-temporal mapping using meso scale and high resolution data; wind estimation by optical flow techniques; and cloud cover estimation using deformable particle systems for cloud tracking.

Land use mapping has already been widely assessed and some techniques such as maximum likelihood classification now belong to the state of the art. However, these techniques

produce a static land use mapping and do not take into account the effect of seasonal changes. Consequently, it is not possible to estimate varying surface parameters. For instance, the vegetation index (NDVI) evolves during the seasons and this parameter greatly influences surface characteristics such as aerodynamic roughness length. Meso-scale optical sensors (NOAA-AVHRR or VEGETATION) provide interesting surface measurements on a daily basis, but with a coarse spatial resolution (1km). Each pixel therefore contains different types of land cover. Pixel unmixing is a technique allowing to estimate the daily reflectance of each type

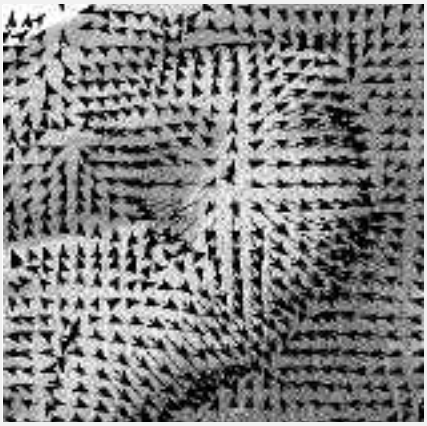

Figure 2: Wind estimation with volume conservation method.

of land cover, provided the land use is known at high spatial resolution on some selected learning sites. An interesting result is that it is possible to map land use on the basis of the temporal behavior of land cover. For this purpose, we have developed a data fusion scheme between high resolution (SPOT-XS) and meso-scale (NOAA-AVHRR) sensors to map land use with both high spatial and high temporal resolution. See an example on figure 1.

Wind can be estimated using meteorological sensors (eg METEOSAT) that output images every 30 minutes, thus making it possible to capture the apparent air displacement. The most popular technique to analyse motion on image sequences is called optical flow. It is based on the hypothesis that the intensity of a moving pixel remains constant during time. Expressed in a Euler-Lagrange framework, this hypothesis makes it possible to design a numerical scheme that yields dense velocity -or wind- fields. This assumption is however unrealistic when analysing cloud displacement. A specific model has been developed for that purpose: we state that the volume of the air column under the clouds remains constant over short periods.

This assumption leads to a new equation close to the optical flow constraint, with an additional term that models the variation of the clouds' area. Results are better than those obtained using optical flow, since the clouds' expansion is correctly estimated (see figure 2).

Deformable structures tracking, when applied to clouds, is a technique that makes it possible to estimate cloud cover with a good accuracy. The difficulty is that clouds usually undergo very

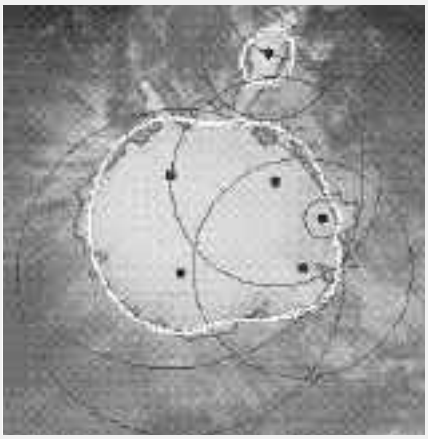

Figure 3: Level set model of a breaking cloud.

important deformation during their motion, they can even split or merge. This causes most classical tracking methods to fail. We have developed an adapted deformable model, based on a particle system controlling a level-set, that models the cloud's boundary. This model is governed by an internal energy -controlling the elastic behavior of cloud motion- and an external one -controlling the adequacy between the model and the image data. This model is able to trackclouds even in the case of topological (split and merge) changes and even if the motion is fast (see figure 3).
As shown by the three examples above, image processing techniques applied to dynamic remotely sensed data can be successfully used to estimate relevant input data for air quality models. Future perspectives concern the evlauation of these techniques with regards to the gain in model accuracy and model automation.

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Data Mining applied to Air Pollution

by Brian J Read

An understanding of the behaviour of air pollution is needed to predict it and then to guide action to ameliorate it. Calculations with dynamical models are based on the relevant physics and chemistry. To help with the design and validation of such models, a complementary approach is described here. It examines data on air quality empirically by Data Mining using, in particular, machine learning techniques, aiming for a better understanding of the phenomenon and a more direct interpretation of the data.

The work of the Database Group at CLRC has long concentrated on the practical application of data management technology. The emphasis is on helping users at the laboratory and externally to exploit the value in data. Implementing databases and providing easy access is the basis for this, supplemented by data exploration and decision support tools. More recently, interest has extended to data mining, or more fully Knowledge Discovery in Databases (KDD). This may be defined as "the non-trivial extraction of implicit, previously unknown and potentially useful knowledge from data". Data mining is just the discovery stage of the whole KDD process. Indeed, most of the work in practice lies in the preparatory stages

of data selection and data cleaning. Extensive data exploration is essential if the data mining is to yield intelligent results.

Data mining is multi-disciplinary: it covers expert systems, database technology, statistics, machine learning ("AI") and data visualisation. It goes beyond directed querying of a database (eg by using SQL) by instead looking for hypotheses or questions rather than detailed answers. Most interest is in mining commercial data - for example credit profiling or market basket analysis. However it is starting to be used in scientific applications too. CLRC as a leading research laboratory has masses of data. Thus there is the motivation to see how data mining techniques might supplement the more traditional scientific analysis in formulating and testing hypotheses. Of specific interest are the induction of rules and neural net models. Considering environmental data, measurement and possibly control of air pollution is increasingly topical. In applying the KDD process, our objectives are two-fold:

- to improve our understanding of the relevant factors and their relationships, including the possible discovery of non-obvious features in the data that may suggest better formulations of the physical models
- to induce models solely from the data so that dynamical simulations might be compared to them, and that they may also have utility, offering (short term) predictive power.

The investigation uses urban air quality measurements taken hourly in the City of Cambridge (UK). These are especially useful since simultaneous weather data from the same location are also available. The objectives are, for example, to look for and interpret possible correlations between each pollutant (NO, NO2, NOx, CO, O3 and PM10) and a) the other pollutants b) the weather (wind strength and direction, temperature, relative humidity and radiance) looking in particular for lags – that is, one attribute seeming to affect another with a delay of perhaps hours or of days. Other factors are possible. For example, clearly noticeable is lower NOx on Sundays through less traffic.

The initial analysis concentrated on the daily maxima of the pollutants. This simplifies the problem, the results providing a guide for a later full analysis. Also the peak values were further expressed as bands (eg *low*, *medium* and *high*). The bands are directly related to standards or targets recommended by the Expert Panel on Air Quality Standards (EPAQS) that the public can appreciate. The two principal machine learning techniques used are neural networks and the induction of rules and decision trees. Expressing their predictions as band values makes the results of such rules and models easier to understand.

Work so far supports the common experience in data mining that most of the effort is in data preparation and exploration. The data must be cleaned to allow for missing and bad measurements. Detailed examination leads to transforming the data into more effective forms. The modelling process is very iterative, using statistics and visualisation to guide strategy. The temporal dimension with its lagged correlations adds significantly to the search space for the most relevant parameters.

More extensive investigation is needed to establish under what circumstances data mining might be as effective as dynamical modelling. (For instance, urban air quality varies greatly from street to street depending on buildings and traffic.) A feature of data mining is that it can *short circuit* the post-interpretation of the output of numerical simulations by directly predicting the probability of exceeding pollution thresholds. More generally, data mining analysis might offer a reference model in the validation of simulation calculations.

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Operational Air Pollution Modelling

by Tiziano Tirabassi

Air quality management and protection require a knowledge of the state of the environment encompassing both cognitive and interpretative elements. The monitoring network, together with the inventory of emission sources, is of fundamental importance for constructing the cognitive framework but neglects the interpretative one. Efficient air pollution management must dispose of interpretative tools which are able to extrapolate in space and time the values measured where analysers are located. However, the improvements to the atmosphere can only be obtained using plans that reduce emissions ie by means of instruments (like air pollution models) able to link the causes (source emissions) of pollution to the related effects (air pollution concentrations). We describe a set of air pollution models developed at the Istituto per lo Studio dei Fenomeni Fisici e Chimici della Bassa e Alta Atmosfera (FISBAT-CNR).

In practice most of the estimates of dispersion of air pollution from continuous point sources are based on the Gaussian approach. A basic assumption for the application of this approach is that the plume is dispersed by homogeneous turbulence. However, due to the presence of the ground, turbulence is usually not homogeneous in the vertical direction.

Various organisations world-wide are currently introducing new advanced modelling techniques based on the results of recent research on the meteorological state of the boundary layer. These advanced modelling techniques contain algorithms for calculating the main factors that determine air pollution diffusion in terms of the fundamental parameters of the atmospheric boundary layer, such as the Monin-Obukhov length

scale and friction velocity. Experimental work and modelling efforts have attempted to parameterize the surface fluxes of momentum, heat and moisture in terms of routinely measured meteorological parameters.

Model Codes

Within this framework, several model codes employing a non-Gaussian analytical solution of the advection-diffusion equation have been developed at FISBAT-CNR, Bologna:

- KAPPAG – This model uses an analytical solution based on the vertical profiles of wind and diffusion coefficients that are power functions of height. The model can handle multiple sources and multiple receptors, simulating time-varying conditions in which each time interval (eg, 1 hour) is treated as a stationary case. The model output is a statistical summary of the concentrations computed at each receptor, during each time step, and due to each source. Partial and total concentrations are computed for hourly and multi-hour averages. Highest and second-highest values are also evaluated.
- KAPPAG-LT – This is the climatological version of KAPPAG, insofar as it produces seasonal and/or annual mean concentrations.
- CISP – This screen model provides a method for estimating maximum ground level concentrations from a single point source as a function of turbulence intensity and wind speed. It is designed for the low-cost, detailed screening of point sources in order to determine maximum one-hour concentrations and is regarded as a useful tool for a screen analysis in that it is a relatively simple estimation technique, providing a conservative estimate of the air quality impact.
- VIM – This is a screening model for estimating maximum ground-level concentrations as a function of turbulence intensity, wind speed and wind direction, in an area with many emission sources. It is considered to be a useful tool for screen analysis as it constitutes a relatively simple evaluation technique that provides a conservative estimate of the air quality impact of a specific multi-source area and a model for the evaluation of the maximum ground concentrations produced by many emission sources.
- MAOC – This is a model for the evaluation of pollutant concentrations in complex orography. The simulation of terrain-induced distortion of flow streamlines is accounted for by modifying the effective plume height.
- VHDM – This practical model evaluates ground level concentrations from elevated sources, utilising a Fickian-type formula where the source height is a simple function of the wind velocity and eddy diffusivity vertical profiles. The model accepts experimental profiles of the above parameters, as well as the theoretical profiles proposed in the scientific literature, such as the vertical profiles of the wind and eddy diffusion coefficients predicted by similarity theory. In the latter case, the model can be applied routinely using as input simple ground level meteorological data acquired by an automatic network.
- M4PUFF – A puff model where the pollutant concentration in puffs is described through the first four moments of its spatial distribution. The model is based on a general technique for solving the K-equation using the truncated Gram-Charlier expansion of the concentration field and the finite set of equations for the corresponding moments. Currently, the type A Gram-Charlier expansion is a classical method for approximating a given distribution with moments of any order, basically consisting of a truncated expansion in terms of Hermite functions, whose coefficients are chosen so as to reproduce the sequence of moments of the distribution up to a given order.
- SPM – This is a practical model based on similarity theory for the dispersion of skewed puffs. It utilises approximate solutions proposed for the dispersion of a cloud of passive contaminant released from an instantaneous source near the ground and particular importance is accorded to describing the interaction between wind shear and vertical diffusion and the process that transforms shear produced skewness into diffusive variance in the wind direction.

The SPM model has been used in a project between Italy and Brazil to investigate the dispersion of radionuclides from the Brazilian Navy's industrial installation 'Centro Experimental ARAMAR' (CEA) located in Iperó, in a rural region of the State of São Paulo.

The performance of the models has been assessed with success in cases of both ground level sources, using data of the Prairie Grass experiment , as well as elevated sources, using data from the EPRI experiment at Kincaid power plant and from the Copenhagen data set. In addition, performance in the case of complex terrain has been evaluated using wind tunnel data from the Fluid Modelling Facility of the US Environmental Protection Agency, Triangle Park (North Carolina).

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Sustainable Development and Integrated Assessment

by Achim Sydow, Helge Rosé and Waltraud Rufeger

A new research project about sustainable development was initiated this year by the Hermann von Helmholtz Association of German Research Centers. In the course of this project at GMD Institute for Computer Architecture and Software Technology interactive and integrated simulation tools for complex environment systems modelling will be developed. The integrated assessment approach to model complex systems on different levels of a hierarchy is introduced as a possible tool to address questions connected with the problem of sustainable development and global change.

With the third millennium approaching, the question of sustainable development is becoming an important concept to investigate different possible scenarios of our future: Is it possible to realise a development that meets the needs of the present and as well as those of future generations? This problem is closely related to the natural resilience and buffer capacity of the biosphere responding to the impact of human development, ie the question of global change.

The progress in human development is becoming increasingly dependent on the environment and may be restricted by its future deterioration. The problem of global change is complex in nature, represented by various interactions that operate on different spatial-temporal scales. Addressing these issues demands an integrative consideration of all relevant interactions between humans and the environment.

The reductionistic approach has failed in providing an adequate analysis of complex, large-scale global phenomena. A more promising route seems to be a more holistic, integrated approach, based on a systems-oriented analysis, which concentrates on the interactions and feedback mechanisms between the different subsystems.

Since the 1970s, there is a growing interest in an integrated approach to the problem of global change, called integrated assessment. In general, integrated assessment can be defined as an interdisciplinary process of combining, interpreting and communicating knowledge from diverse scientific disciplines in such a way that the whole cause-effect chain of a problem can be evaluated from a synoptic perspective with two characteristics: it should have added value compared to single disciplinary oriented assessment and it should provide useful information to decision-makers.

Integrated assessment is an iterative, continuing process, where on the one hand integrated insights from the scientific community are communicated to the decision-making community and on the other hand experiences and learning effects from decision-makers form the input for scientific assessment. In Europe, integrated assessment has its origins in the population-environment, ecological and acidification research. In North America the attention was mainly concentrated on the economic modelling. During the last years, integrated assessment models have increasingly focused on climate change and sustainable development.

The main questions under consideration today are: human health management and population growth, management of fossil fuels and renewable energy resources, safeguarding of food and fresh water and the stability of the biogeochemical cycles with respect to the human perturbations.

To model these complex systems, the Pressure-State-Impact-Response concept may be used as organizing principle for achieving a plausible division of the cause-effect chains into subsystems. The Pressure System represents social, economic and ecological driving forces underlying the pressure onto the human and environmental system. The State System represents physical, chemical and biological changes in the state of the biosphere, as well as changes in human population and resources / capitals. The Impact System represents social, economic and ecological impacts as a result of human and/or natural disturbance. The Response System represents human intervention in response to ecological and societal impacts.

Modern integrated assessment approaches use a hierarchic structure to overcome the complexity problem of modelling. At the lower level of aggregation, economy-energy models operate in multi-year time steps with national or regional political boundaries. Their regional and distributed output data may be used in theme-specific models like RAINS (Regional Acidification Information and Simulation) or IMAGE (Integrated Model to Assess the Greenhouse Effect) at the next level of aggregation. Their results of characteristic simulations provide a guide line to setting up metamodels which establish the building blocks for integrated assessment models, eg the TARGETS system (Tool to Assess Regional and Global Environmental and health Targets for Sustainability) of the National Institute for Public Health and the Environment, The Netherlands/RIVM, at the highest level of aggregation.

This hierarchic system of models describes the problem at different levels of aggregation and integration. Therefore it provides a flexible framework of simulation tools which can help to answer the multifaceted questions regarding the understanding and managing of complex environmental systems. Based on this concept the GMD Institute for Computer Architecture and Software Technology will develop an interactive and distributed modelling system which is supposed to tackle questions connected with the problem of sustainable development.

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The Modelling and Control of Living Resources

by Jean-Luc Gouzé

The aim of the new research team COMORE (Modelling and Control of Renewable Resources) at INRIA Sophia-Antipolis is to apply methods from control theory (feedback control, estimation, identification, optimal control, game theory) and from the theory of dynamic systems, to the mathematical modelling of living exploited resources (renewable resources) and their management. COMORE is a joint project with the CNRS Villefranche-sur-Mer. The main research themes are 'dynamics and control of fishery and aquaculture', 'modelling and control of bioreactors', 'modelling and control of phytoplankton growth', 'modelling of forest dynamics' and 'mathematics of biological modelling'.

COMORE is interested in the mathematical modelling of biological systems, more particularly of ecosystems submitted to a human action (the framework is thus that of renewable resources). It is now clear that it is important to know how to model and regulate the exploitation of these resources by man. Our conceptual framework is that of Control Theory: a system, described by state variables, with inputs (action on the system), and outputs (the measurements available on the system). In our case, the system will be an ecosystem, modelled by a mathematical model (generally a differential equation). Its variables will be, for example, the number or the density of populations. The inputs could be the actions which one exerts on the ecosystem: eg action of the man (fishing effort, introduction of food, etc), or action of an external factor (pollution, light, etc). The outputs will be some product that one can collect from this ecosystem (harvest, capture, production of a biochemical product, etc), or some measurements (the total number of individuals for example).

This approach begins with the mathematical modelling of the system. This stage is fundamental and difficult, because one does not have rigorous laws as in physics. It is then necessary to study the properties of this mathematical system, which often has some particularities. Let us take a simple example: in reality, the variables are positive because they are populations; is it the same in the mathematical system?

One seeks to study the qualitative behavior of the system, the existence of equilibria, their stability, the existence of periodic solutions... These qualitative questions are fundamental because they tell us whether or not the model is viable (the model does not predict the extinction of any species, etc). Specific problems are posed by the biological origin of the models: functions or parameters are uncertain, or unknown; what can we say on the behavior of the model?

It is necessary to develop new techniques to study these problems. In the same way, the strong structure of the models makes it possible to define classes of systems, for which one develops adapted techniques: for example the well-known models of Lotka-Volterra in dimension n, describing the interactions between n species.

Finally, we will consider problems of regulation (how to keep a variable at a given level) and observation (how to estimate the state variables from the outputs). The biological origin of the model gives new constraints for these classical problems.

Modelling of a Chemostat – Growth of the Marine Plankton

We work in collaboration with the Station Zoologique of Villefranche-sur-Mer (CNRS), which developed a chemostat (small bioreactor where algae or cells grow on a substrate) fully automated and managed by computer; this system is well adapted to the application of the methods resulting from the theory of control. Our current work consists of studying and validating models of growth for the plankton in a variable environment (light, food, etc). The growth of the plankton is the basis of all the production of the organic matter of the oceans (fishes, etc); however, the existing traditional models (Monod, Droop) are often unsatisfactory. We seek to obtain models valid during the transitory stages, away from the equilibrium.

Growth of phytoplankton in the chemostat (CNRS, Villefranche sur Mer, Laboratoire d'Ecologie du Plancton Marin).

A fundamental problem is that of the validation, or invalidation, of these models: how to accept, with a certain precision, a model by comparing it with experimental noisy data ? The traditional approach, which consists of identifying the parameters of the model by minimizing a criterion of variation between the outputs of the model and the data, is often inefficient. We are developing new methods more pertinent for the biologists.

Modelling of a Bioreactor – Observation and Control

Naturally, the topics above lead to the more general problem of modelling and control of a bioreactor. The bioreactors are having growing importance in many domains related to the human environment: alimentary (fermentation), pharmaceuticals (production of medicine), wastes (waste water treatment), etc. Let us mention the problem of observation in these systems, where the measurements are rare and expensive: a software sensor, or observer, is a differential system which estimates asymptotically the (unmeasured) variables of the model. It is based on the model and the outputs of the process.

Modelling of Exploited Systems (fishing, forests, etc)

The scale of the problems changes here; data are rare and noisy. We consider some important methodological problems: how to model the stock-recruitment relationship of the fish (the relationship between the number of fertile adults and eggs they produce). How does one optimize the exploitation of fisheries or forests with respect of some criteria?

For more information on COMORE, see http://www.inria.fr/Equipes/COMORE-eng.html

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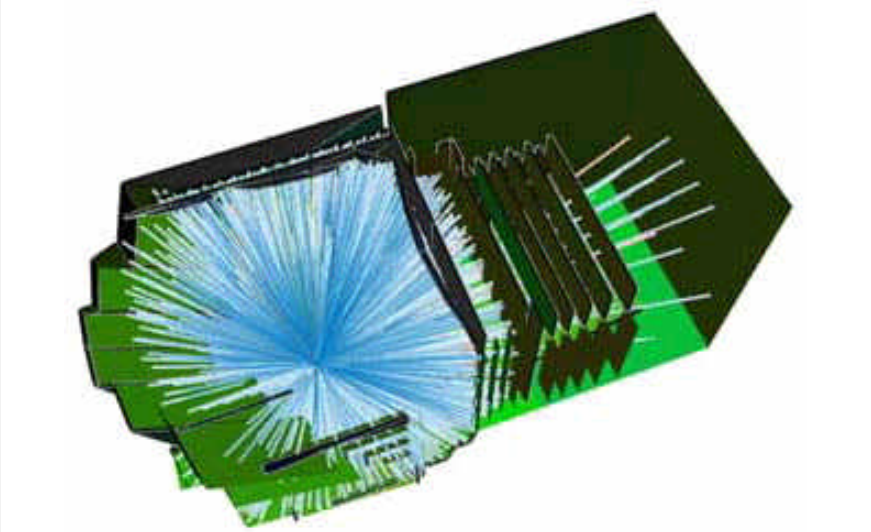
ECHO and NARSYS – An Acoustic Modeler and Sound Renderer

by Nicolas Tsingos and Jean-Dominique Gascuel

Computer graphics simulations are now widely used in the field of environmental modelling, for example to evaluate the visual impact of an architectural project on its environment and interactively change its design. Realistic sound simulation is equally important for environmental modelling. At iMAGIS, a joint project of INRIA, CNRS, Joseph Fourier University and the Institut National Polytechnique of Grenoble, we are currently developing an integrated interactive acoustic modelling and sound rendering system for virtual environments. The aim of the system is to provide an interactive simulation of global sound propagation in a given environment and an integrated sound/computer graphics rendering to obtain computer simulated movies of the environment with realistic and coherent soundtracks.

Computer graphics and acoustics research have both given rise to a variety of models which are often based on the same geometrical formalisms. However, despite the growing development of multi-modal simulations, it appears that there is a lack of modelling systems offering integrated design of visual and acoustic properties of dynamic virtual environments and combined computer rendering of image and sound. Our system attempts to fill this gap by reading in a 3D computer model of an environment and providing tools to specify positions and properties of virtual sound sources, microphones and acoustic materials, later used for sound simulation.

Simulating sound waves propagation is achieved by the ECHO module using an original hierarchical radiant exchanges method similar to the radiosity technique used for lighting simulations. The method accounts for the temporal aspect of sound propagation and both diffuse and mirror specular reflections which are of primary importance. We have also developed original techniques to model sound diffraction phenomena. The hierarchical aspect of our approach allows for tuning the complexity and realism of the simulation, depending on the application and computing resources, eg a coarser model is used when less computing power is available. Thus, the solution can be updated at interactive rates after each modification of the environment. The



Example of a simulation in a concert hall (the Opera de La Bastille in Paris).

sound simulation is completely integrated in an animation module, used to specify movement of sound sources, microphones, cameras or any object in the environment over time.

The second part of the system is a sound rendering engine NARSYS (Natural Audio Rendering SYStem) which is used to filter *rough* sound samples with the solution obtained from the ECHO module in order to produce a soundtrack with realistic sound reverberation, attenuation, Doppler shifting, multi-channel audio output etc. Images rendered from camera viewpoints and sound received by microphones can then be combined to create a realistic animated movie with perfectly coherent soundtrack.

The flexibility of the system makes it well suited for a variety of applications, from generating soundtracks for computer animation movies or interactive sound walkthroughs for virtual environments to interactive acoustic design of concert halls or environmental acoustic planning. A collaboration with the acoustics department of the Centre Scientifique et Technique du Batiment (CSTB) in Grenoble has been established to validate our simulation technique on a variety of environments, including several concert and opera halls like the Opera de la Bastille in Paris. Further information can be found at http://www-imagis.imag.fr/~Nicolas.Tsingos/

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STOY – An Information System for Environmental Noise-Planning

by Ole Martin Winnem and Hans Inge Myrhaug

The new international airport at Gardermoen forced the Royal Norwegian Army to relocate their activities to Rena. This movement into a new area with farmers and small villages at both sides of the training area put major constraints on what training that can be performed in the area. SFT (Norwegian Pollution Control Authority) has given rules for the training regarding time of activity, noise in the nearest buildings and area of training. The area where the new training fields are located has cold winters with stationary air down in the valley. This can give a temperature variance of 20(C from the training area in the mountains and down in the valley where the civilian population lives.

Listeners are affected by the time of day when the noise is heard. During the day, they can accept much noise, in the evening they accept less noise, and at night they are very sensitive to noise. Also, the kind of information they are given in advance regarding noisy activities, influences their attitude to the noisemaker. If they are given no information, they tend to get more frightened when loud and warlike noises occur. On the other hand, if a noisy activity is announced in advance as an airplane show, they can accept almost any kind of noise.

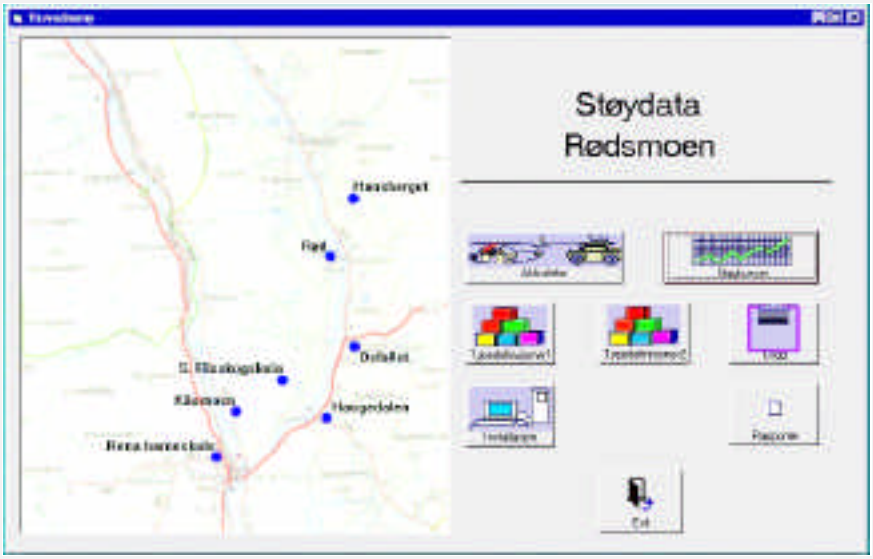
The kind of weather and the time of the year are also important factors. During winter people are much more indoors and thus isolated from the noise. During summer - and particularly when the weather is nice - people are outdoors and therefore much more sensitive.

With these conditions the military have to optimise the activity regarding to noise.

The Monitoring and Planning System

STOY (noise) is a project for logging, monitoring, identifying, computing and planning noise.

The system is based on seven components: User Interface component, Monitor component, Estimation component, Planning component, Database component, Logging component and the Noise recognition component.



The military training area. The identified points are measurement stations for noise, temperature and wind.

The logging component retrieves data from seven stationary and one mobile measurement station for noise and weather conditions. And then send them to the Database component. The database component stores the logged data, the calculated data, the recognised data and the data from the planning component. The Noise recognition component retrieves the logged data from the database and identifies the noise source. The Monitoring component is the day-to-day monitoring system for the user. The Estimation component estimates the noise propagation for a given noise source by using a mathematical model that pays respect to terrain formations. The Planning component is the support system for activity planning. The component has two subparts, one for generation of plans and one for critique of plans. The planning component is using knowledge intensive case based reasoning and rules for evaluating the plans.

Other Application Areas

The military all over the world gets more and more restrictions on their training. This gives a market for noise planning systems to help them plan their activities inside the restriction threshold.

Major airports are getting new restrictions on how much noise they can generate, and the airplane companies are getting restrictions on how much noise they can create on a particular airport. Both have a planning problem for which type of plane that can be used to maximise the number of passengers they can transport.

Industrial noise has become a problem all over the world. An example is fields for testing of plane engines where the company must plan the activity according to the civilian population in the area. ■

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Partial Differential Equations in Porous Media Research

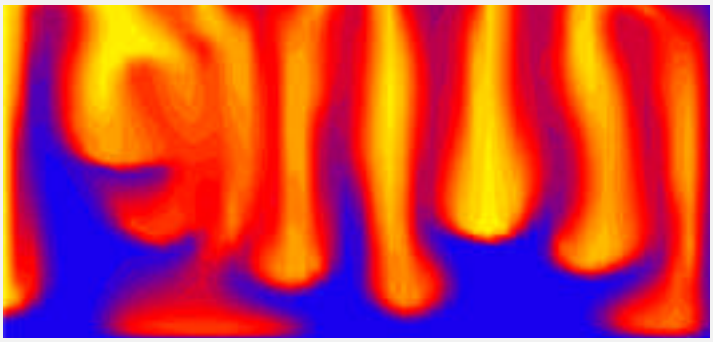
by Hans van Duijn

Mathematical modelling of flow and transport through porous media plays an important role in environmental studies as well as in reservoir engineering. Applications include the spread of pollutants from a landfill through the soil system and of oil spills in the subsurface, the intrusion of salt seawater in coastal aquifers, and new methods for enhanced oil recovery and underground gas storage. At CWI several of such problems are studied, ranging from very applied to theoretical research.

Although already intensively studied in the past, transport phenomena in porous media still yield new and challenging mathematical problems in the field of nonlinear partial differential equations (PDEs), free boundary problems, and homogenization procedures. Moreover, detailed numerical studies are necessary to improve the prediction capacity of the related models. CWI's research focuses on the mathematical modelling of transport processes in the subsurface, and on the qualitative analysis and numerical study of the governing PDEs.

In the field of PDE research particular attention was given to systems consisting of a convection-diffusion equation coupled with an ordinary differential equation. A special case, modelling salt uptake by mangroves, involves non-local convection. In a collaboration with the University of Bonn the interface between fresh and salt groundwater in the presence of wells is studied. The interface appears as a free boundary in an elliptic problem in which, depending on the pumping rate of the wells, a cusp singularity develops. In the case of heterogeneous media the interface was studied numerically, using a moving mesh Finite Element Method. Knowledge of the behaviour of the interface is important, eg, to estimate in how far seawater intrudes in aquifers in the Dutch coastal area when drinking water is pumped out. This research was highlighted for example at a tele-conference 'Mathematics and environment: problems related to water', an initiative of the European Mathematical Society, which was held last December simultaneously at three locations: Amsterdam, Madrid, and Venice.

The study of density-driven flow in porous media concentrates on brine transport problems related to high-level radio-active waste disposal in salt domes. High salt concentrations give rise to non-linear transport phenomena such as enhanced flow due to volume (compressibility) effects and the reduction of hydrodynamical dispersion due to gravity forces. A non-linear dispersion theory for this case, proposed by S.M. Hassanizadeh (Delft University of Technology), was verified using experimental data from the Technical University of Berlin.



A fingering pattern of fresh/salt fingers in a porous medium (light color = salt, dark = fresh).

The pressure in active gas reservoirs in the Netherlands becomes insufficient to meet the needs during the winter period.

Therefore Gas Unie/NAM (Nederlandse Aardolie Maatschappij) intends to store gas in depleted gas reservoirs which are no longer in production. These reservoirs act as a buffer to meet peak demand. In an ongoing project sponsored by NAM CWI studies gas injection into a reservoir, in order to understand and quantify the mixing (diffusion/ dispersion) of injected gas with residual gas in old reservoirs, and develops a numerical code to predict this mixing.

Another project concerns soil remediation techniques. Organic contaminants may be removed from the soil either by pumping methods or by injecting air (air sparging), which enhances biodegradation and volatilization. The corresponding flow of groundwater, organic contaminant and air is described using multi-phase flow models. For air injection into groundwater in a horizontally layered medium accurate numerical solutions of the full transient two-phase flow equations were found and an almost explicit solution for the steady-state air flow just below a less permeable soil layer was derived. To model pumping of a lens of light organic liquid from an aquifer, multi-phase seepage face conditions were applied at the well boundary. For two different geometries of the lens similarity solutions provided good approximations of the removal rate and the location of the remaining contaminant as a function of time.

Finally, in a recently started project PDE's with higher order mixed derivatives are studied. Such equations arise in models for unsaturated groundwater flow, taking into account dynamic capillary pressure.

See also : http://dbs.cwi.nl/cwwwi/owa/cwwwi.print_projects?ID=5

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Descartes System – Interactive Intelligent Cartography in Internet

by Gennady Andrienko and Natalia Andrienko

Descartes assists users in the exploration of spatially referenced statistical data, ie economical, demographic or ecological data related to geographical locations. It incorporates knowledge about thematic cartography to automatically generate thematic maps that correctly visualize selected data. It also supports the further, interactive exploration of these maps. Descartes was formerly called IRIS (see 'IRIS generates Thematic Maps' by Hans Voss in ERCIM News No. 27, October 1996, page 13).

Current Geographic Information Systems (GIS) specifically support the analysis and manipulation of geometric information. However, they are weak regarding their support of visualizing spatially referenced statistical data. Major shortcomings are:

- Users bear full responsibility for a correct selection of presentation techniques. Consequently, they must proficiently know principles of cartographic presentation, have to spend considerable time and efforts for map production, and cannot entirely concentrate on their task of analysis and problems to solve.
- GIS are typically complex and difficult to operate; significant training is required.
- GIS do not sufficiently support the further exploitation and exploration of produced maps, ie their use in data analysis. Descartes overcomes these shortcomings. It provides intelligent mapping support and a wide spectrum of functions for interactive visual data analysis.

Intelligent Mapping in Descartes

Descartes incorporates the knowledge on thematic cartography in the form of generic, domain-independent rules. To choose automatically the adequate presentation techniques for data selected by the user, Descartes accounts for data characteristics such as types of data fields (numeric, categorical, or logical), value ranges, and relations among the fields such as comparability, hierarchical inclusion, or their covering a meaningful whole (eg male and female cover the set of all persons).

Interactive Visual Data Analysis

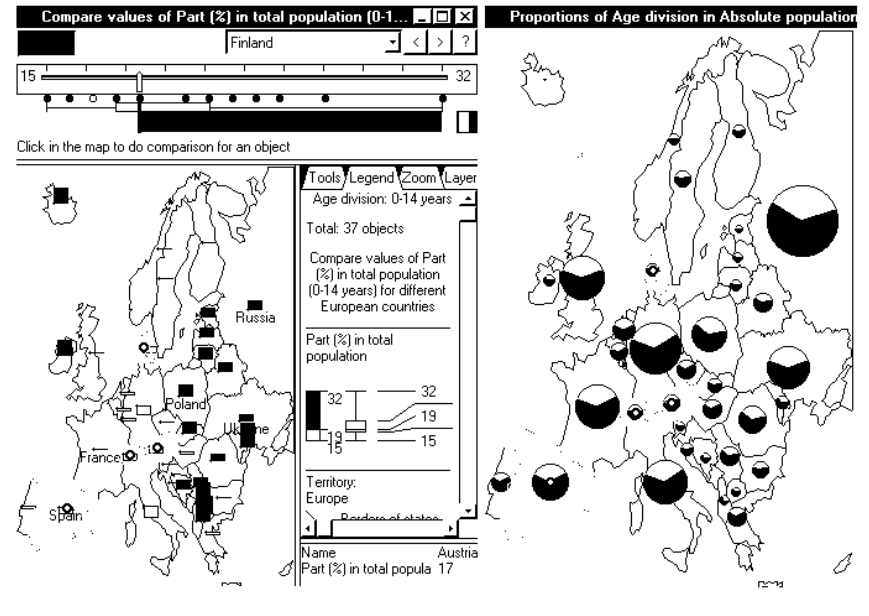
Maps on computer screens should not be mere reproductions of paper maps, rather they should be dynamic and reactive to user's actions. Descartes provides various tools to interactively manipulate the maps so as to make them more expressive and to exploit the potential of specific visualization techniques for data exploration.

An example is the visual comparison technique. Figure 1 demonstrates this technique in application to a bar map that represents values of a numeric attribute by heights of bars. The left map enables visual comparison with an interactively selected number 19 (median). The bars show how the attribute values for the countries differ from 19: the higher is a bar, the greater is the difference. Whether a difference is positive or negative is seen from the bar orientation and color. The map is redrawn in real time as the user changes the reference value for the visual comparison, for example, by dragging the slider along the number line (see the upper left corner of the figure).

Dynamic Linking and Highlighting

All data displays produced by the system are linked. As the mouse moves through a map or a supplementary non-cartographic presentation, the system highlights the objects touched by the cursor in all currently visible displays. For example, on the figure below a reader

can see three linked displays: two maps and a presentation with a dot plot and a "box-and-whiskers" plot (upper left) that suggests a summary of the value variation of the percentages of children in population. The mouse cursor has been positioned on the third dot from the left in the dot plot. As a result, the countries



Various cartographic presentation methods for age categories.

with the corresponding value of the attribute 'percentage of children' are highlighted in both maps.

Applications

Descartes has been applied to several sets of statistical data, eg data about European countries, the City of Bonn, census data for Leicester. Some demonstrators can be accessed and operated remotely at the URL http://allanon.gmd.de/and/java/iris/ A set of thematic maps for Rhein-Sieg area produced in Descartes is available at http://allanon.gmd.de/and/java/showmap/

Current State and Further Development

Descartes is implemented in Java and available as a stand-alone program running on Personal Computers under Windows 95/NT, and as an application based on Java-applets running under any Java-enabling Internet browser. Descartes has been fully operational now for more than two years. In September 1996, it was included in the Top 1% web applets and Top 10 web applets lists by the independent Java Applet Rating Service.

A commercial version of Descartes is available from the GMD spin-off company DIALOGIS Software & Services GmbH. Descartes has been integrated with the data mining workbench KEPLER, which is also available from DIALOGIS. Further development of Descartes is to be done within CommonGIS project submitted on the Esprit Thematic call "Information Access and Interfaces" and accepted for funding.

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Travelling Waves in Nonlinear Diffusion-Convection-Reaction Processes

by Róbert Kersner

Special solutions play an important role in the study of nonlinear partial differential equations (PDE's) arising in mathematical biology. Confronted with a mathematical model in the form of an initial or a boundary value problem for a partial differential equation or a system of such equations, the foremost desire of a practitioner is to solve the problem explicitly. If little theory is available and no explicit solutions are obtainable, generally the ensuing attack is to identify circumstances under which the complexity of the problem may be reduced. The study of these problems belongs to the main research directions of the Applied Mathematics Laboratory at SZTAKI.

In cooperation with the University of Twente, a technique has been developed for determining whether or not a nonlinear, possibly degenerate parabolic partial differential equation admits a travelling-wave (TW) solution, ie solution of the form f(x-ct) which does not change the shape f and where the speed c is constant. This technique is suitable for investigating properties of such travelling waves as well.

In ecological context, the different terms in such kind of partial differential equations represent the birth - death process, diffusion and convection. Typical examples for them are the Fisher or logistic equation, which is the archetypical deterministic model for the spread of an advantageous gene in a population of diploid individuals, the

Nagumo equation, which models the transmission of electrical pulses in a nerve axon, and the Richards (or nonlinear Fokker-Planck) equation. Analogous systems of PDEs were proposed as models for the chemical basis of morphogenesis by Turing in 1952.

The principal contention of our method is that the study of the travelling wave solutions of partial differential equations above is equivalent to the study of the singular Volterra-type nonlinear integral equations in the following sense: the partial differential equation has a monotonic travelling wave solution connecting two states with a given speed if and only if the integral equation has a non-negative solution which is zero at these states.

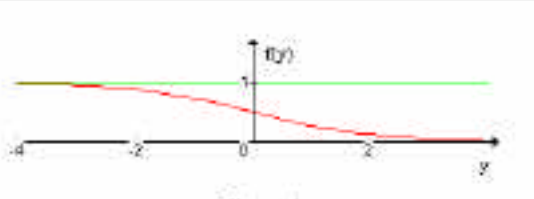

Figure 1: The travelling wave solutions exist only for speeds exceeding the minimal speed.

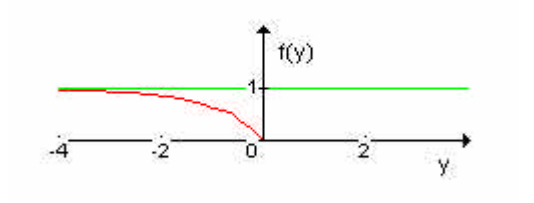

Figure 2: A travelling wave solution with a sharp front.

For the Fisher-type equations a typical result is that the travelling wave solutions exist only for speeds which are bigger than the minimal speed and have the form given in Figure 1. The minimal speed is an unknown of the problem, having great practical importance. In many cases, after some time the general process moves with this velocity.

It may happen that a travelling wave solution has a sharp front (see Figure 2). This is the case, for example, for the generalised Fischer-type model, when the density dependence of the diffusion coefficient is power-like. The travelling wave solutions with not minimal speed have no sharp front (see Figure 1), but the unique wave with minimal speed has (see Figure 2). Note that this travelling wave has attractor property: after some time all the solutions of the original partial differential equation with initial data from a given class will take the form and the speed of this wave. Using the above mentioned integral equation method one can obtain these kind of results almost algorithmically, together with good estimates for the minimal speed.

Our developed technique provides an alternative to phase-plane analysis and has several advantages with respect to this classical approach. Turning to the results of the theory of integral equations the user can easily identify circumstances which guarantee the existence of the required waves and can decide if the wave has a sharp front or not. Models with the same characteristics arise in several scientific fields, for example heat transfer, combustion, reaction chemistry, plasma physics, etc.

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ESIMEAU – Water Resources Management and Modelling in Semi-Arid Areas

by Fadi El Dabaghi

The main objective of the ESIMEAU project is to build an infrastructure of an integrated system to be used as a single decision support system for the management of water related issues. Such an open work platform will embody numerical models and simulators operating on spatial geographic databases, as well as data acquisition and data management tools. The direct beneficiaries are spatial planners and decision makers who will find through such a system, efficient operational facilities in the preparation and the installation of planning and/or emergency measures directly related to water – both as a resource and as a natural hazard – for semi-arid areas.

The main actions to be addressed are:

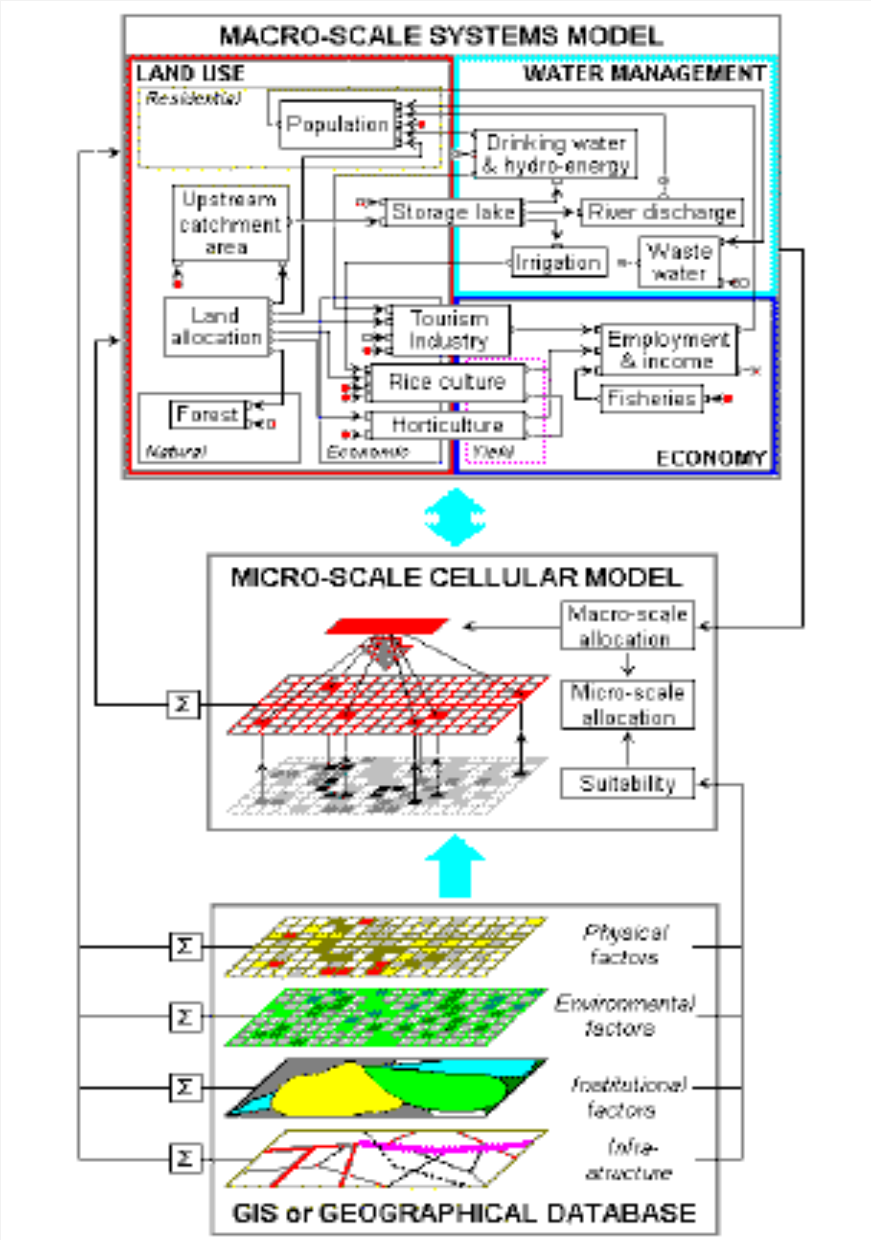
- development or integration of tools for the management, analysis and treatment of heterogeneous data (acquired in situ or through satellite images) taking into account the semi-arid climate characteristics (variability, heterogeneity, size)
- modelling and analysis of rapid phenomena such as floods and solid transport or slow scale ones such as eutrophication, erosion, climate change and the development of appropriate numerical algorithms for a better and realistic simulation reproducing the real physical situation of the phenomena under investigation
- integration of these conventionally separately treated application domains into a single application through intelligent interfaces within an appropriate and user-friendly framework.

System Architecture

The architecture of the system to be developed will consist of three levels containing some modules. Modules of general type such as graphics, data base management systems (DBMS), geographic information systems (GIS), shells, simulators, etc.) will constitute a part of the backbone of the system. The other specific modules taking care of particular physical applications (hydrology, hydraulics/hydrodynamics, eutrophication, etc.) will be developed independently. The numerical modules are dealing with the mechanical treatment of eutrophication while only a state of the art on the physical modelling of flood/release risk management occurring in watersheds will be delivered. The three levels of the system are:

- at the top level the ESIMEAU integrator will allow the end user without prior or deep knowledge in computer technology, to access and use in a user-friendly environment all the operational modules data: consultation, treatment, or visualisation, numerical simulation , and post-processing (graphs, iso-curves, thematic maps, etc.)
- at the intermediate level are specific modules for data treatment and numerical simulation/prediction
- at the lower level are located data access, consultation, modification and visualisation interfaces.

For building the architecture of ESIMEAU, general conventional standards tools will be used. Geographical Information Systems (GIS) such as ArcInfo and Arcview, Idrisi; Database Management Systems (DBMS) such as Dbase, FoxPro, Access, Oracle; shells such as CLIPS, KAPPA, KEE; simulators such as, Powersim, Slam, Cellular Automata based systems; integrators such as ArcView, KAPPA, and to a less extent Geonamica, will be considered.



Structure of an integrated model representing spatial dynamics at different geographical scales, with linkages between Macro-level, Micro-level and GIS components.

Representation of Spatial Dynamics at Different Geographical Scales

Many environments will generally have at least two strongly linked components, one for macro-level, macroscopic long range and large scale processes (processes at the global level of the region studied) and a second for processes operating on the micro-level, short range, and micro-scale (processes at the level of small sub-sections of the region studied). Models at both levels are tightly integrated and exchange information back and forth through a number of state variables specially conceived for this purpose. It will be supplemented with all the facilities required to be used as a stand-alone application.

The system will be designed and adapted taking into consideration the specifications of its main end-users; ie planners, policy makers, and model builders. The integration of models operating at different geographical and temporal scales, is important to ESIMEAU. A built-in simulation language and associated modelling tools, will ease the implementation and the integration of the models selected. A linkage to commercial GIS packages will facilitate the storage and manipulation of geographical data as well as their integration into a single multi-level model.

ESIMEAU is supported by the European Commission's INCO DC programme. It started in December 1997 and has a duration of three years. Partners are: INRIA; ORSTOM, French National Institute of Scientific Research for Development through Co-operation; FORTH; RIKS, Research Institute for Knowledge Systems, The Netherlands; Ecole Nationale Polytechnique, Algiers, Algeria; Ecole Supérieure d'Ingénieurs de Beyrouth, Lebanon; EUCLID, Lebanon; Ecole Mohammadia d'Ingénieurs, Morocco; Office National d'Eau potable, Morocco; Centre International des Technologies de l'Environnement de Tunis, Tunisia. The project is administered by ERCIM.

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ERCIM Working Group Environmental Modelling

by Achim Sydow

The purpose of the ERCIM Working Group Environmental Modelling is to build and maintain a network of ERCIM researchers in the field of environmental modelling and simulation. The working group is open to anybody affiliated with an ERCIM institute. Since its establishment in 1995, the working group has undertaken a variety of activities in order to promote the co-operation and joint research activities of groups working in the field of environmental modelling and simulation.

To date, the ERCIM Working Group Environmental Modelling has carried out three workshops. The fourth workshop is already in its preparation phase.

On 11 October 1996, the kick-off meeting of the Working Group took place at INRIA Rocquencourt. Points of discussion were the enlargement of the Working Group through finding new partners and the definition of certain research topics for future projects.

The Working Group held its first workshop on Air Pollution Modelling in Berlin, Germany, from 7-8 April 1997. The workshop was hosted by the GMD Institute for Computer Architecture and Software Technology Berlin. The workshop chairman was Achim Sydow (GMD). In total 28 participants from 10 European countries attended the workshop and listened to 18 lectures, presenting recent research results in the field of air pollution modelling and simulation.

The second workshop of the Working Group on Remote Sensing for Air Pollution Analysis was held in Strasbourg on 11 September 1997. It was part of the International Conference *Umweltinformatik '97 - Informatique pour l'environnement '97*. The workshop chairman was Isabelle Herlin (INRIA). The lectures and discussions at the workshop focussed on the usage of data derived from remote sensing for air pollution analysis and forecast.

The Working Group carried out its third workshop on Air Pollution Modelling and Measuring Processes on 20-21 April 1998 in Madrid, Spain (see article on page 4). The workshop was hosted by the Environmental Software and Modelling Group of the Computer Science School at the Universidad Politecnica de Madrid (UPM). The workshop chairman was Roberto San José (UPM). As highlights of the programme, invited lectures were given by representatives of the local environmental authorities of the State of Madrid and the State of Brandenburg (Germany). The participation of these invited speakers was supported by the ERCIM Office.

Submission of Joint Project Proposals

The first project activity of the Working Group was the submission of the project proposal STEPUP in the TMR Programme of the European Commission on 15 June 1995. Further activities of the Working Group have led to the preparation of the second project proposal. The proposal *DECAIR - Development of an Earth Observation Data Converter with Application to Air Quality Forecast* has been submitted to the European Commission Programme Environment and Climate. Under the coordination of the ERCIM Office, Working Group members from Germany, France, Spain and the United Kingdom have participated in the project.

Further activities of the Working Group have led to the preparation of the third project proposal. The proposal *PANDORE - Pollution Analysis and Modelling with Databases and Observations from Remote Sensing* has been submitted to the European Union-India Economic Cross Cultural Programme. Under the coordination of the ERCIM Office, Working Group members from Germany, France and United Kingdom together with a partner from India have participated in this project.

ERCIM Fellowship

An applicant has been accepted for the first ERCIM Fellowship within the framework of the Working Group. He has started his fellowship at the Working Group member team of INRIA Rocquencourt on 1 June 1998 and after 9 months he will continue at GMD Institute for Computer Architecture and Software Technology.

To date, members from nine research teams of ERCIM institutions in seven European countries are collaborating within the Working Group. More information about the ERCIM Working Group Environmental Modelling is available at http://www.first.gmd.de/applications/em.html

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Task Parallelism in an HPF Framework

by Raffaele Perego
and Salvatore Orlando

High Performance Fortran (HPF) is the first standard data-parallel language. It hides most low-level programming details and allows programmers to concentrate on the high-level exploitation of data parallelism. The compiler automatically manages data distribution and generates the explicit interprocessor communications and synchronizations needed to coordinate the parallel execution. Unfortunately, many important parallel applications do not fit a pure data-parallel model and can be more efficiently implemented by exploiting a mixture of task and data parallelism. At CNUCE-CNR in Pisa, in collaboration with the University of Venice, we have developed COLT$_{hpf}$, a run-time support for the coordination of concurrent and communicating HPF tasks. COLT$_{hpf}$ provides suitable mechanisms for starting distinct HPF data-parallel tasks on disjoint groups of processors, along with optimized primitives for inter-task communication where data to be exchanged may be distributed among the processors according to user-specified HPF directives.

COLT$_{hpf}$ was primarily conceived for use by a compiler of a high-level coordination language to structure a set of data-parallel HPF tasks according to popular task-parallel paradigms such as pipelines and processor farms. The coordination language supplies a set of constructs, each corresponding to a specific form of parallelism, and allows the constructs to be hierarchically composed to express more complicated patterns of interaction among the HPF tasks. Our group is currently involved in the implementation of the compiler for the proposed high-level coordination language. This work will not begin from scratch. An optimizing compiler for SKIE (SKeleton Integrated Environment), a similar coordination language, has already been implemented within the PQE2000 national project (see ERCIM News No. 24). We only have to extend the compiler to support HPF tasks and provide suitable performance models which will allow the compiler to perform HPF program transformations and optimizations. A graphic tool aimed to help programmers in structuring their parallel applications, by hierarchically composing primitive forms of parallelism, is also under development.

High-level description and associated task graph of a parallel application obtained by composing three data-parallel tasks according to a pipeline structure where the second stage has been replicated by hierarchically composing the pipeline with a farm structure.

The figure shows the structure of an application obtained by composing three data-parallel tasks according to a pipeline structure, where the first and the last tasks of the pipeline produce and consume, respectively, a stream of data. Note that Task 2 has been replicated, thus exploiting a processor farm structure within the original pipeline. In this case, besides computing their own jobs, Task 1 dispatches the various elements of the output stream to the replicas of Task 2, while Task 3 collects the elements received from the replicas of Task 2. The communication and coordination code is however produced by the compiler, while programmers have only to supply the high-level composition of the tasks, and, for each task, the HPF code which transforms the input data stream into the output one. The data type of the channels connecting each pair of interacting tasks is also shown in the figure. For example, Task 2 receives an input stream, whose elements are pairs composed of an INTEGER and an NxN array of REAL's. Of course, the same data types are associated with the output stream elements of Task 1. Programmers can specify any HPF distribution for the data transmitted over communication channels. The calls to the suitable primitives which actually perform the communications are generated by the compiler. Note that communication between two data-parallel tasks requires, in the general case, P*N point-to-point communications if P and N are the processors executing the source and destination tasks, respectively. The communication primitives provided by our run-time system are however highly optimized: messages are aggregated and vectorized, and the communication schedules, which are computed only once, are reused at each actual communication.

COLT$_{hpf}$ is currently implemented on top of Adaptor, a public domain HPF compilation system developed at GMD-SCAI by the group lead by Thomas Brandes, with whom a fruitful collaboration has also begun. The preliminary experimental results demonstrate the advantage of exploiting a mixture of task and data parallelism on many important parallel applications. In particular we implemented high-level vision and signal processing applications using COLT$_{hpf}$ and in many cases we found that the exploitation of parallelism at different levels significantly increases the efficiencies achieved. ■

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Development Tools for Distributed Services

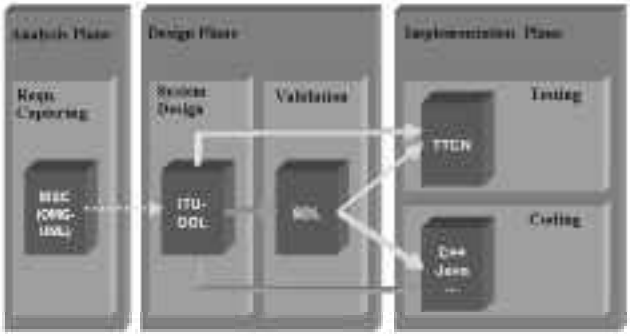
by Marc Born and Linda Strick

The increasing complexity of distributed telecommunication services has lead to a requirement for powerful methods and tools to support the design and specification process. The GMD Institute for Open Communication Systems has developed a methodology covering the whole development life-cycle. Case Tools that support the design process have the Y.SCE tool (Y.Service Creation Environment) developed by GMD and the commercially available TAU toolset from Telelogic. Both tools are connected to perform a tool chain which has been successfully used in several national and international projects for the development of distributed services. This article gives a brief overview of the methodology, the tools and further work.

The methodology developed by GMD scientists provides notations and guidelines to cover all stages of the development life-cycle for arbitrary (telecommunication) services. It describes all activities that are necessary to define a distributed service and is a complete description of both, stages and steps involved in the analysis, design and implementation plane.

The Reference Model for Open Distributed Processing (RM-ODP) [ODP] has been used as a general framework for the tool supported design methodology as it provides object-oriented concepts and principles for structuring the system design. The design process itself is not a pure top-down approach, but is an iterative usage of each of the stages from an abstract level down to the detailed specification and implementation. Repetition of steps is needed if errors are detected either by validation on the design plane or by testing the implementation.

Different languages and techniques are used to support the specification of the models. These techniques include OMT (Object Modelling Technique), TINA ODL (Telecommunication Information Networking Architecture/Object Definition Language) and SDL [Z.100] (Specification and Description Language).



Used notations for methodology.

In order to get acceptance for new software development methods it is not enough to propose the method from a theoretical perspective only. Tools have to be provided to enable the usage of the method.

For the Analysis Plane the Y.SCE tool provides graphical notations for defining the Enterprise Model. A Use Case Model and an Organisational Model can be defined which are stored in an information repository. For the behaviour, high level Message Sequence Charts (MSCs) can be captured using the TAU toolset from Telelogic. Both tools are connected to allow that MSCs can be attached to the Use Cases and a navigation between them is possible.

To support the Design & Validation Plane the Y.SCE tool provides a graphical notation for the Object Description Language (ODL) and is able to import and export textual ODL files. To support CORBA (Common Object Request Broker) based systems, IDL files (Interface Definition Language) can also be imported and exported. The ODL information is stored in the repository. It is possible to establish links between the Use Cases and ODL entities to navigate along these links. In order to describe the functional behaviour, the Y.SCE tool generates SDL skeletons which can be imported into the TAU tool. The behaviour information will be added there. The TAU tool provides functionality for simulation and validation of the specification models defined in the different planes.

To support the Implementation and Testing Plane automatic generation of implementation language code (currently C and C++) is possible either directly from Y.SCE or from TAU. Depending on the behaviour model the generated code is more or less abstract.

In order to test, whether the final implementation is conform to its specification the ITEX tool, a Telelogic tool, which is also part of the TAU toolset, is used for the derivation of test cases. To bridge the gap between abstract test suites and executable test cases the GMD Institute for Open Communication Systems has developed an additional tool to perform testing in a distributed CORBA environment.

The application of the described methodology to the design of distributed services ensures a higher quality of the resulting service and a shorter time to market. Further work will be done to support automated deployment of the services to appropriate middleware by tools.

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The Use of Wavelets in Seismics and Geophysics

by Nico Temme

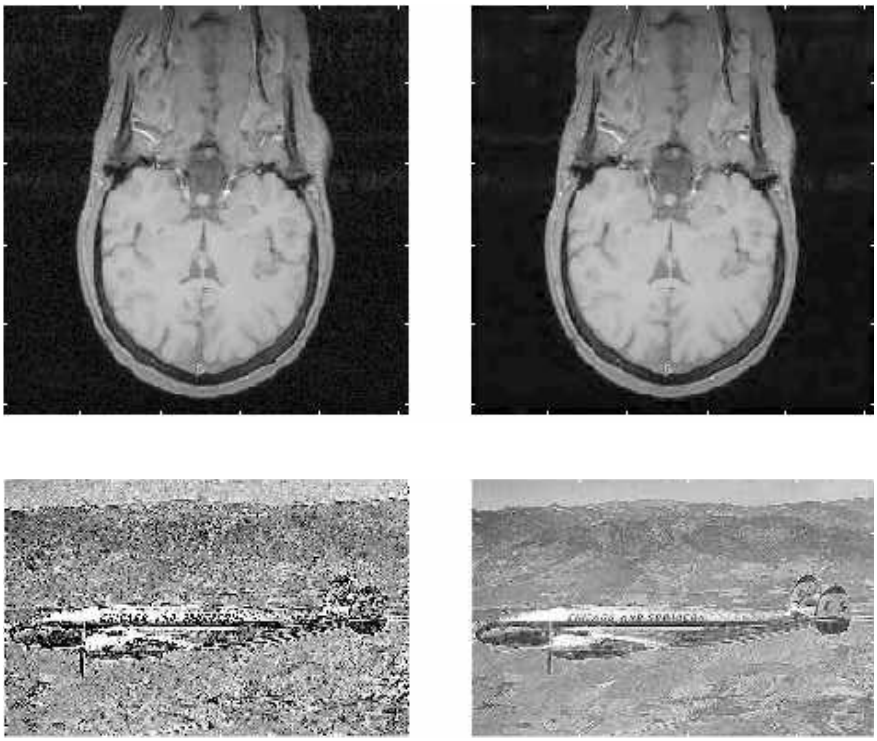
Wavelets are wave patterns of small size that can be used to analyze rapid changes in a signal, sharp contrasts in an image, and structures at different scales. The wavelet method, developed in the eighties and now provided with a sound mathematical basis, has become a powerful tool in the field of data compression, noise suppression and processing of images and signals. At CWI wavelets are studied in a project financed by the Technology Foundation STW which focuses on the application of wavelets in seismology and geophysics.

A wavelet is a wave-like function with short extension: its graph oscillates only over a short distance, or damps very fast; its mean value over the whole domain equals zero. A wavelet is localized both in frequency and position. From this 'mother wavelet' a whole family of other wavelets is derived by displacement and scaling. In this family every scale is represented for every wanted position. Wavelet analysis operates as a microscope: as a wavelet family contains 'building blocks' of arbitrary small scale, we may zoom in at any time on any detail of the signal. Wavelets are well suited to detect the presence of fractal components in observational data. As we observe images and acoustic signals mainly by contrasts, wavelets can be very effective in storing and transmitting such images and signals by data compression. Wavelets are also successfully applied for, eg, removing noise in old sound recordings and restoring images from MRI and CT scans.

Research on wavelets and its applications in The Netherlands takes place for instance at the Royal Dutch Meteorological Institute KNMI (structure of the clouds), Delft University of Technology (soil structures, for oil exploration), Groningen University (image processing in medicine) and CWI (analysis of geophysical/seismic signals). CWI's research is focused on the development and use of directional time-scale analysis methods.

An important research topic is the combination of the Radon transform (also called X-ray transform — a well-known technique for reconstructing a 3D object from a number of cross-sections) and the wavelet transform. A rigid mathematical formulation of this 'Wavelet X-ray Transform', its basic properties and its discretization have been obtained. A fast algorithm for this combined transform is also under development. The computer code has been established in a Matlab environment and the first results are promising.

The 'Wavelet X-ray Transform' is applied to the filtering of two-dimensional seismic data sets. These images contain information about the subsurface of the earth such as the localization of geological interfaces. However, they also contain irrelevant parts, for example contributions from waves coming directly from the explosion (that is used to generate the signals) to the detection point. CWI's wavelet method of filtering away the irrelevant parts prior to extraction of the relevant parameters is based on the idea that relevant and disturbing parts in an image can be separated based on distinction in position (or time), scale (or frequency) and direction.



A compressed image of a brain-slice (top right) is stored six times as efficient as the original (top left). The resolution is retained. This is achieved by ignoring negligible wavelet coefficients. A corrupted image of a plane (bottom left) is cleared (bottom right). First a wavelet decomposition of the image is made. Then the coefficients corresponding to the noise part are muted. The final reconstruction of the image is based on the modified wavelet coefficients. In both cases MATLAB Graphical User Interface tools were used.

Secondly, research is conducted jointly with KNMI on the problems of polarization in seismic signals, where an estimation of the spectrum is made by preprocessing the signal data. In a seismogram, the waves coming from the source and arriving at the Earth's surface at different arrival times appear as so-

called phases. These phases, which can be seen as the ground motion due to the arrival of a particular wave coming from the source, are all measured during a short time period. A research aim is to find the time periods in a seismogram, when they appear. Furthermore we want to analyze these phases accurately.

Analysis of a short segment in a longer record by spectral estimation, ie, studying the frequency components of the Fourier spectrum, is hampered by the fact that its spectrum cannot be determined exactly if the data process is stochastic or a noisy deterministic signal.

A seismogram is a non-stationary data process and hence, instead of considering the Fourier spectrum, a direct estimate of the time-varying spectrum is more appropriate. For this we used the wavelet transform. Since at higher scales the wavelet transform too cannot deal with the uncertainty introduced by the short segment, we first preprocessed the segment with a tapering algorithm, which smoothes the data by multiplying the data segments with some window function, and then took the wavelet transform of the new data. The first mathematical results of our research contain error and convergence estimates of the new algorithm. Successful experiments with synthetic data will be followed by tests with real seismic data in collaboration with KNMI.

Other recently started research concerns the design of an algorithm based on the wavelet transform for the detection of time points, where the several phases appear in the seismogram. This is relevant for, eg, distinguishing a (nuclear) explosion from an earthquake and locating the source of the seismic event. Together with the seismology department of KNMI, physical properties of the seismic signals, especially their scaling behaviour, are used to refine the algorithm. See also http://www.cwi.nl/cwi/projects/wavelets.html

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ATS – Adaptive Teaching System

by Marcus Specht

Web-based educational systems are becoming more and more popular and are used by a heterogenous user group. Users of educational Web-based systems differ in their goals, professional background, interests and knowledge of the subject matter. To optimize the efficiency and effectiveness of the learning process educational systems should adapt to this user features.

ATS is a Web-based educational system that mainly uses adaptation to the knowledge and the interests of learners to generate individualized hypermedia instruction. The system is based on a domain model of the subject matter, a didactical model how to teach a curriculum and learner modelling on different levels, eg preferences, interests, knowledge.

The domain model contains the knowledge about the subject matter. The knowledge base is represented as a conceptual network with different types of units and relations between them. Several types of information are associated with each unit. These are different kinds of text (introduction, several stages of teachtexts, summary), examples, demonstrations, playgrounds, and tests. In addition, each unit has prerequisites (units that the student should be familiar with before working on the unit) and consequences (possible outcomes and effects on other units). The tests, prerequisites and consequences are weighted according to their importance for a unit.

The didactical model represents the teacher's knowledge of how to teach units. It consists of two main parts: teaching strategies and diagnostic knowledge. The system has a default strategy for each concept type and teachers can specify a preferred strategy for a concept if needed. The diagnostic component stores the knowledge about several types of tests and how they have to be generated and evaluated.

In the learner model is stored the information about the material that a learner has used and how successful he/she worked on the material (eg, if tests are solved correctly, if the playground estimations were good or to what extend teachtexts where requested). Every action of a student has consequences for updating the learner model depending on the involved learning material and the previous experiences of a learner.

Based on these three components individualized web-content (html, vrml, pictures) can be generated and presented to a learner. Both, knowledge and interests are diagnosed at the beginning of the learning process with ATS and updated through the learning process to keep track of the changing needs. Taking into account the interest and the knowledge of a learner the system can adapt the instructional process on several levels:

- adapting the curriculum by selection of content
- adapting the presentation of contents by choosing appropriate media and combining them (adaptive multimedia presentation)
- adapting the teaching strategies for specific contents
- annotating hyperlinks
- recommending hyperlinks and contents.

Some adaptive methods used in ATS have been empirically evaluated and showed improvements in efficieny and effectiveness of learning compared to classical static hypermedia learning environments. Based on this results further research has to be done on complex interactions between adaptive methods and the dependencies between different user features and the effectiveness of adaptive methods for educational purposes. Beside that further developments will try to integrate social learning processes and goal based adaptation methods in ATS. An authoring tool for ATS could be easily

integrated in the domain independent ATS framework and would allow new ATS systems to be build by teachers without any html or programming experience.

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Abstract Test Suite

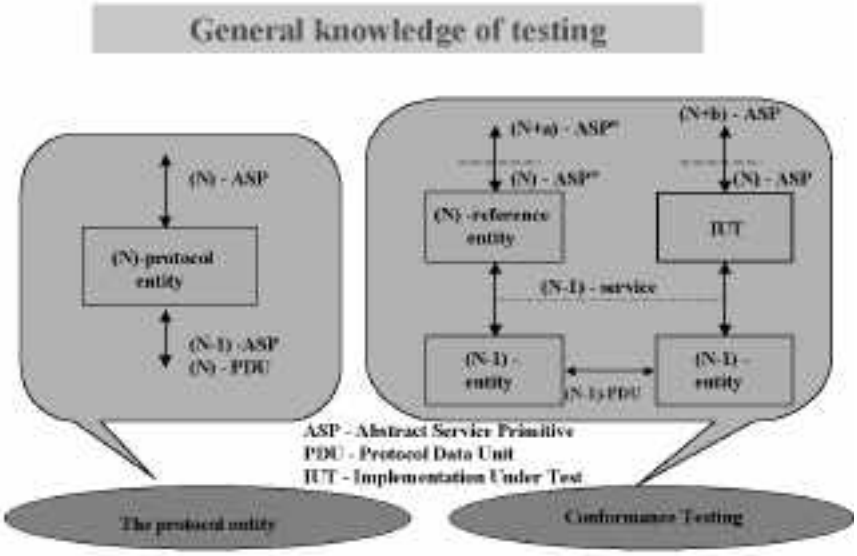
by Katalin Tarnay and Abdalla Areik

With the increasing number of different communication networks and protocols, it comes more and more important to check whether a protocol implementation is conform to the formal specification. A new method for analysing abstract test suites, a fundamental step of conformance testing has been developed at the Communication Protocol Laboratory of SZTAKI.

A communication protocol can be considered as an (N)-Protocol entitiy having upper and lower interfaces. The Protocol Data Units (PDU) and the Abstract Service Primitives (ASP) cross these interfaces. The basic blocks of conformance testing can be seen in the Figure. The Implementation Under Test (IUT) is tested in a layered architecture. N stands for the layer number, the test methods are abstract. An abstract test method describes how an IUT is to be tested, given at an appropriate level of abstraction to make the description independent of any particular realization, but with enough detail to enable tests to be specified for this method.

The fundamental notion of conformance testing is the abstract test suite. Traditional methods to derive an abstract test suite are based on extended finite state machines or labelled transition graphs. Our new idea is based on AI tools, namely on rule-based systems. The advantage of using this method is to get better information with higher confidence and to have wider possibility to modify the test actions.

The abstract test suite is composed of abstract test cases. An abstract test case is a complete and independent specification of an action required to achieve a specific test purpose. According to our method, test steps and test cases are converted to a rule-based system.



The basic blocks of conformance testing.

Rule-based system representation provides the possibility of integrating expert systems into the conformance tester. The most popular mode of knowledge representation within expert systems is the mode obtained by the use of rules or rule-based systems. Such rules are called IF-THEN. For understanding and maintaining, validation and ease of documentation, some kind of rule organization should be followed. Each group should be ordered, the rule-group ordering is determined according to the conclusion attributes, but it is often advocated to limit the rule to a single conclusion attribute.

The application of a rule-based abstract test suite will be demonstrated on a simple protocol called Inres Protocol. This is a connection oriented protocol that operates between two entities, the Initiator and the Responder. The protocol entities communicate by exchanging the Protocol Data Units (CC, CR, DT, AK and DR.) The communication between two protocol entities takes place in three distinct phases: connection establishment, disconnection, and data transfer phase. In each phase only certain Protocol Data Units and Abstract Service Primitives have meaning.

In our research we try to use a rule-based system for conformance test cases. In other words, we attempt to generate from the test cases written in TTCN notation (Tree and Tabular Combined Notation) rules. Since the description of the test cases is in TTCN and we want to convert these cases to rule-based systems, we can use other specification languages (eg SDL) as well. Confidence factors and uncertainity can be related to the rules. This method is expected to be applied in protocol engineering. It is especially interesting for abstract test suite developers. These applications provide a feedback to further research.

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European TMR Project System Identification

by Jan van Schuppen

The System Identification project aims at: joint research on selected topics, increased transnational cooperation, joint training of post-doctoral and pre-doctoral researchers, and interaction with industrial, service, and commerce companies, and with governmental laboratories, leading eventually to joint applied research. The research objectives are to produce algorithms and theory for system identification for nonlinear systems, for multi-input/multi-output linear systems, and for control. The project is carried out by the European Research Network System Identification (ERNSI) which consists of nine research teams in seven European countries. It receives support through the EU Training and Mobility for Researchers (TMR) – Research Networks. The project started on 1 March 1998 and will run for four years. It provides primarily fellowships for young researchers at the post-doctoral and at the Ph.D. student level.

System identification concerns the construction and evaluation of mathematical models, obtained from data, in the form of dynamical systems. The project is motivated by the need for such models in problems of control, signal processing, prediction or forecasting, simulation, monitoring, and analysis, such as arises in engineering, economics, environmental sciences, and biology. The problems of system identification to be considered are the modeling of phenomena by dynamical systems, the realization problem of transforming one system representation into another, the derivation of system identification algorithms, the performance evaluation of such algorithms, and combined identification and control.

The ERNSI Network was created in 1992 by several research groups, with the aim to stimulate cooperation between the research teams in the field of system identification. ERNSI has held annual workshops since 1992.

Its research teams: are active leaders in the field in Europe; span a broad spectrum of academic disciplines, from mathematics to engineering and econometrics; have experience in training Ph.D. students and post-docs, also from abroad; regularly receive visitors from other countries, and maintain intensive international contacts; and are active in organizing research at the international level, such as in editorial boards of journals and in programme committees of conferences. Teams from the following institutions participate in ERNSI: CWI Amsterdam (coordinator); Institute for Econometrics, Operations Research and System Theory — Technical University Vienna; CESAME — University of Louvain (Leuven); INRIA Sophia Antipolis; IRISA — University of Rennes; Department of Engineering — University of Cambridge; CNR-LADSEB Padova; Royal Institute of Technology (KTH) Stockholm; Institute for System Technique — University of Linköping. For more information, see http://www.cwi.nl/cwi/departments/PNA2/tmrsi.html

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Reflective Teams – Active Learning and Information Integration in Open Environments

by Heinz Mühlenbein

Research in the Reflective Teams project at GMD System Design Technology Institute aims at the analysis and development of systems that operate on large data spaces with unknown properties or interact with technical or natural processes with unknown behavior. The main emphasis of is on fundamental algorithmic research and on novel software architectures for real-world intelligent systems. The R-TEAMS system combines evolution of structure, active learning, reflection and teamwork of agents in a distributed fashion. The R-TEAMS architecture consists of teams of reflective actors which communicate via distributed blackboards.

R-TEAMS is designed for the following problems, which might exist individually or in combinations:

- Search of large data spaces. The data spaces are given in mathematical representation or, in the case of real-world data, as sets of value pairs obtained from observation or from simulation of real-world processes.
- Interaction with real-world processes. The tasks and the behavior of the processes cannot be completely taken into account when the system is designed, since the tasks are not known in advance nor the situations which they will refer to.
- Simulation of real-world processes. In complex applications data often cannot be generated by mathematical models, but has to be numerically computed by simulating the physical process.

Scientific Approach

In our opinion, an artificial system with real world intelligence cannot be preprogrammed and remains unchanged, but it has to have capabilities to learn and evolve. This requires:

- evolution of structure
- active learning
- reflection
- teamwork of agents.

The R-TEAMS approach tries to fulfill these requirements within a unique framework based on parallel distributed problem solving. Many agents of varying functionality and granularity cooperate or compete in teams, referred to as reflective teams. They define subtasks and subgoals, perform subtasks, pursue subgoals and eventually produce subresults that are then combined by other agents to yield a solution, eg, an optimum, a model, a prediction or an action. The idea is to draw on the inherent network structure of such problems and to reflect it in the architecture of the systems. Asynchronous interaction of agents and teams of agents turned out to be a suitable principle of organization for implementing division of labor and teamwork.

Theory

In many real-world applications, especially in spatial domains, it is easy to decompose the application into agents together with their interaction structure. But in the past interactions have been assumed to be one of the two extreme cases – each agent interacts with any other agent or the agents do not interact at all. It has been independently discovered that teams of agents with constrained interactions can be conveniently described by a network. The vertices of the graph represent agents. There is an edge between agent A and agent B if they interact, ie, they have something in common. This can be a common variable, a common action to be agreed on, a common part of the environment, sharing of sensor information etc. The task of the agents is to solve a given problem in a decentralized way. We have started to investigate three different approaches to render efficient solutions of problems defined on such networks:

- graphical models
- team theory
- game theory.

R-Teams Components

R-TEAMS applications consist of the following major components:

- Agent: ranging from simple automata to reflective cognitive agents
- Team: defining relations between the agents
- Interaction: between agents, teams and environment
- Environment: depending on the type of application.

Our research is focused on the development of different models implemented within a single platform. The models and tools developed are tested through various applications.

Current Applications

Current application include:

- control of an anthropomorphic hand-eye robot with two manipulators and 3D stereo vision
- placement of antennas for mobile radio communication
- predicting the risk of a credit
- ptimization of decomposable functions.

The project is supported by the Real World Computing Partnership.For more information, see http://set.gmd.de/AS/rteams/proj.html

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Design, Specification and Verification of Interactive Systems '98

by David Duce

The DSV-IS'98 workshop took place at The Cosener's House, Abingdon (CLRC's conference centre) from 3 to 5 June. Organized under the auspices of the Eurographics Association, and with sponsorship from ERCIM, this was the fifth in an annual series of workshops. The workshop attracted 41 delegates from France, Italy, The Netherlands, Norway, Spain, UK, Australia and the USA, and two invited speakers from the USA and Ireland. ERCIM was well-represented in the organizing committee and attendees.

The workshop was chaired by Peter Johnson and Panos Markopoulos from Queen Mary and Westfield College, University of London. The opening address was given by Dan Olsen from Carnegie-Mellon University. Dan's paper was entitled "Interacting in Chaos", a very impressive demonstration of chaos in technology: electronic 'gadgets' taken from every available pocket: mobile phone, pager, Palm Pilot, tiny solid state recording device (holds 90 secs of audio messages). There is a chaotic state (in the mathematical sense - minor perturbations produce wildly different long term outcomes), a divergent state, yet the creation of helpful tools demands convergence. Human usage demands regularity. He argued for a focus on surface representations in order to support truly large communities. He argued that in the chaotic order brought about by Internet-based information and collaboration, we should concentrate on human-consumable data types and the fundamental media for representing information: text/language, images and pictures, audio, video, 3D environments (stressing the importance of sense of place and of what is around the body), and tactile information. His paper concludes "Consider also that much of the WWW information is generated by algorithms rather than by people. There is inherent regularity in such output that

is waiting to be exploited by other tools. All that remains is for us to design them. This, I believe, is where the future of interactive technology lies."

John McCarthy, University College Cork, Ireland, gave the second invited talk entitled: "The viability of modelling socially organised activity". He spoke about the growing interest in HCI, CSCW and cognitive science into conceptualizing activity as socially organized and situated. This brings in what John referred to as the "messy stuff" of the social and experiential. He argued that the kinds of studies characteristic of research into socially organized activity provide insights which should not be ignored by designers. He illustrated this with examples from a study carried out by the universities of Cork and York into the workings of ambulance control centres in Cork and West Yorkshire. He pointed out that decisions about technology are decisions about work. The studies focused on how staff deal with emergency calls, how they locate the source, build representations of what is happening in their area and decide which ambulance to dispatch. Such work has a moral dimension which also cannot be ignored. He concluded with a discussion of strategies and frameworks that might take such 'messy stuff' into account during design.

Twenty three of the submitted papers were selected for presentation and covered a broad range of topics, modelling the design of interactive systems, the role of representations in designing interactive systems, formal support for the design of interactive systems, advances in model-based design and specification and verification of interactive systems. In addition, there were three working group sessions. The workshop split into three groups, each containing a mix of skills and disciplines. Groups were presented with three problems: design of an interactive guidebook (inspired by work at the University of Lancaster in mobile computing), reading for writing and an accident scenario from cruise control in American cars. Groups could work on one or more problems, though initially each of the groups was asked to work on a different problem. In the closing session of the workshop, the working groups reported to the full workshop.

From an organiser's point of view, the meeting was very successful. The technical presentations were of high quality and displayed a real breadth and depth of interest in the field across Europe, North America and Australia. It was pleasing to see many new faces at the workshop, and there was a real sense of a growing, dynamic, inter-disciplinary community. The workshop proceedings will be published by Springer-Wien later in the year.

It is planned that next year's workshop will be held at the University of Minho, Braga, Portugal, with Mario Martins and Jose Campos as local organisers and David Duke (University of York) and Angel Puerta (Stanford University) as programme co-chairs.

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EP98 – the Seventh Conference on Electronic Publishing

by Jacques André

INRIA recently organized (and ERCIM sponsored) EP98, the seventh Electronic Publishing conference, in Saint-Malo, in the framework of a week consecrated to digital documents and typography. This conference was held from 1-4 April at Saint-Malo, France.

About three hundred people participated in the events, more than a half having registrated to EP98 and its tutorials. Attendants came from America, Far East and Europe (with a very great number of people from Finland) and 'even' from France (very few people actually!).

For twelve years, the series of EP meetings has been a hot spot for technological watch. Indeed, it is at these meetings that such concepts as active documents, document restructuring and so on, first appeared.

This year's conclusion is that research in this area is far from being complete, even though the Web only seems to be concerned with the development of commercial products these days. Some thought that the OpenType or MM and Unicode fonts marked a pause. On the contrary, research is revealing very novel openings in object-oriented or constrained character modelling – including non Latin characters, legibility on screens, etc. Others opinions were that paper is out. On the contrary, the concept of intelligent paper, that bridges the gap between the physical and digital worlds, puts it back in the spotlight. Among the best lectures was the invited talk from Grenoble-Xerox research center. Some thought that we knew how to manage multimedia. On the contrary, Allen's logic opens up brand new and exciting possibilities in terms of temporal management. In short, we are witnessing a transition from a narrow and specialized technical subject to a wide area of research, a new discipline.

Proceedings are available as:

- R.D. Hersch, J. André, H. Brown (Eds.): Electronic Publishing, Artistic Imaging, and Digital Typography, 7th International Conference on Electronic Publishing, EP'98. Held Jointly with the 4th International Conference on Raster Imaging and Digital Typography, RIDT'98, St. Malo, France, March/April 1998. Proceedings.
- LNCS 1375, Springer-Verlag, Heidelberg, 1998 . VIII, 575 pp. ISBN 3-540-64298-6, Softcover, DM 114,- http://link.springer.de/link/service/series/0558/tocs/t1375.htm

The cover has been designed at EPFL, Switzerland by using very new imaging technologies and can be found at: http://www.irisa.fr/ep98/BookCover.pdf

EP 2000 ?

This series is far from dying! Its main problem is to find its own approach, to be independent of the Web fashion and far of the printing technology. In that

way, the EP steering committee is looking for an unambiguous new acronym (EP seems to be too much printing oriented although EP means Electronic Publishing whose meaning is broader than Editing!). Anyway, EP2000 should be organized in the United States. Have a look at http://www.irisa.fr/ep98/ep00.html

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CALL FOR PAPERS

ERCIM Working Group on Constraints Workshop

Amsterdam, 23-25 September 1998

The ERCIM working group on Constraints will hold its third workshop in conjunction with the 1998 annual workshop of the CompulogNet (Esprit Network of Excellence on Computational Logic) area 'Constraint Programming', 23-25 September 1998.

Authors are invited to submit abstracts on ongoing research in all areas of Constraint Programming and Constraint Processing. Position papers describing current projects are also welcome. The submission deadline is 20 August. Please send an electronic version of the abstract in postscript, latex or plain text to ERCIM working group secretary, Eric Monfroy (eric@cwi.nl). Authors will be notified of acceptance/rejection by the end of August.

The workshop is jointly organized by: Philippe Codognet, INRIA, Krzysztof R. Apt and Eric Monfroy, CWI with support from the CompulogNet and ERCIM. See also http://www.cwi.nl/~eric/ERCIM/Workshops/Workshop3/CFP/index.html

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CALL FOR PARTICIPATION

INRIA-Industry Meeting

Paris, 26 November 1998

The next INRIA-Industry meeting will be held in Paris on 26 November 1998. It will be consecrated to applications in the telecommunications and multimedia sector. This meeting will provide industry operatives from this extremely competitive area with an opportunity to discover the latest technological innovations stemming from INRIA research. More than 50 applications will be presented that involve leading edge technology in various domains such as wireless networks, the Internet, sophisticated human-machine interaction and mobile applications.

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CALL FOR PAPERS

IEEE Multimedia Systems '99

Florence, Italy, 7-11 June 1999

This is the 6th edition of the International Conference on Multimedia Computing and Systems organized by the Institute of Electrical and Electronics Engineers. IEEE ICMCS is an annual conference aiming at bringing together researchers, developers and practitioners from academia and industry, working in Multimedia. We encourage submissions of scientific and technical papers, panel, tutorial, workshop and poster proposals. Conference topics include but are not limited to:

- Operating System Support
- Distributed Multimedia
- Human Computer Interaction
- Multimedia Databases
- Multimedia Tools
- Multimedia Applications.

Important dates:

- paper submission deadline: 15 October 1998
- notification of paper acceptance: 15 January 1999
- camera ready copy: 15 February 1999
- panel, tutorial, demonstration, exhibit deadline: 31 December 1998
- notification of acceptance: 15 January 1999

Fore more information, see: http://www.dsi.unifi.it/~icmcs99

Please contact:

Conference secretariat – University of Florence
E-mail: icmcs99@dsi.unifi.it

CALL FOR PARTICIPATION

Second European Conference on Research and Advanced Technology for Digital Libraries

Heraklion, Crete, Greece, 21-23 September 1998

This conference is the second of a series of European conferences on research and technology for digital libraries. Panel sessions, result demonstrations and poster sessions are also included in the conference programme. A limited number of fellowships for the conference are available. The objectives of the conference are: to bring together researchers from multiple disciplines whose science relates to the development of digital libraries; to establish a forum for discussion of issues such as interoperability, multilinguality, intellectual property policy, and information commerce. For more information see : http://www.ics.forth.gr/2EuroDL/

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FORTH – **Jacques Santer**, President of the European Commission, visited the Foundation for Research and Technology – Hellas (FORTH), located at the Science and Technology Park of Crete, on the 10th of April 1998. Mr Santer was accompanied by

Jacques Santer, President of the European Commission (left), during his visit to the Foundation for Research and Technology – Hellas (FORTH) , accompagnied by Stelios Orphanoudakis, Director of ICS-FORTH (right).

senior Greek officials, including the Alternate Minister of Foreign Affairs, the Deputy Minister of National Economy, the General Secretary of the Region of Crete, members of the Greek Parliament, and other distinguished guests. Mr Santer was, by all means, impressed by the high quality of scientific work conducted at the Institutes of FORTH. He expressed his full support for the research and development activities and the systematic efforts made by FORTH to contribute to the industrial exploitation of new, promising technologies, at the regional, national, European and international levels.

■

GMD – **Dennis Tsichritzis**, Chairman of GMD's Executive Committee, was awarded the 'Premio Italia', the German-Italian scientific prize. The 'Premio Italia' includes the fields of economy and science and is awarded by the German-Italian Economic Association and the German-Italian Science Committee. Tsichritzis received the prize for his merits in science and research and for furthering the German-Italian co-operation. The prize was awarded 26 May 1998 in Düsseldorf in the presence of Pier Luigi Bersani, Italian Minister for Industry, Trade and Craft Trades, and Dr. Enzo Perlot, Italian Ambassador to Germany.

■

CLRC – **Albert Westwood** has been appointed as the new Chairman and Chief Executive of the Council for the Central Laboratory of the Research Councils, CCLRC. He succeeds Paul Williams, the first Chairman and Chief Executive of CCLRC, who retired on 31 March 1998. Williams was appointed Director of the Rutherford Appleton Laboratory in 1986 and to

The former and the new Chairman and Chief Executive of the Council for the Central Laboratory of the Research Councils, CCLRC, Paul Williams (left) and Bert Westwood.

his present post on the creation of CCLRC in 1995. Commenting on the appointment of his successor, Paul Williams said: "Dr Westwood comes to CCLRC after a distinguished career in science and engineering in the USA. His experience is just what the Rutherford Appleton and Daresbury laboratories need at this point in their lives. He has an impressive international reputation and brings many years of experience in managing large scale research. CCLRC is fortunate to have such a man in the Chief Executive's chair." Albert Westwood has commented: "It is indeed a real privilege for me to be invited to become a member of this great laboratory. I am really looking forward to doing all I can to help sustain and enhance the laboratory's reputation as an international scientific leader, and to continue to build up its role as a critical resource for exciting technical ideas and innovative developments that, over time, will contribute significantly to national prosperity".

■

SARIT – **A new name for ERCIM's Swiss member institute** – the general assembly of SGFI (Schweizerische Gesellschaft zur Foerderung der Informatik und ihrer Anwendung) has decided to change its name to SARIT (Swiss Association for Research in Information Technology). The change of the name stands for a stronger international orientation and emphasizes the focus on research. The membership structure remains basically the same: the professors of computer science or related areas at the Swiss universities and Swiss companies active in research in information technology. The SARIT web pages can be reached under http://www-dbs.ethz.ch/sarit/.

■

European Research Consortium for Informatics and Mathematics

ERCIM

The European Research Consortium for Informatics and Mathematics (ERCIM) is an organisation dedicated to the advancement of European research and development, in the areas of information technology and applied mathematics. Through the definition of common scientific goals and strategies, its national member institutions aim to foster collaborative work within the European research community and to increase co-operation with European industry. To further these objectives, ERCIM organises joint technical Workshops and Advanced Courses, sponsors a Fellowship Programme for talented young researchers, undertakes joint strategic projects, and publishes workshop, research and strategic reports, as well as a newsletter.

ERCIM News is the in-house magazine of ERCIM. Published quarterly, the newsletter reports on joint actions of the ERCIM partners, and aims to reflect the contribution made by ERCIM to the European Community in Information Technology. Through short articles and news items, it provides a forum for the exchange of information between the institutes and also with the wider scientific community. ERCIM News has a circulation of 6,500 copies.

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