

Computer Treatment of Large Air Pollution Models

Zahari Zlatev



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Computer Treatment of Large Air Pollution Models Zahari Zlatev, 1995-01-31 Models are often the only way of interpreting measurements to investigate long range transport and this is the reason for the emphasis on them in many research programs B E A Fisher A review of the processes and models of long range transport of air pollutants Atmospheric Environment 17 1983 p 1865 Mathematical models are potentially at least powerful means in the efforts to study transboundary transport of air pollutants source receptor relationships and efficient ways of reducing the air pollution to acceptable levels A mathematical model is a complicated matter the development of which is based on the use of i various mechanisms describing mathematically the physical and chemical properties of the studied phenomena ii different mathematical tools first and foremost partial differential equations iii various numerical methods iv computers especially high speed computers v statistical approaches vi fast and efficient visualization and animation techniques vii fast methods for manipulation with huge sets of data input data intermediate data and output data

Computational Challenges in the Numerical Treatment of Large Air Pollution Models I. Dimov, 2018 The air pollution and especially the reduction of the air pollution to some acceptable levels is an important environmental problem which will become even more important in the next 10 20 years This problem can successfully be studied only when high resolution comprehensive models are developed and used on a routinely basis However such models are very time consuming also when modern high speed computers are available Indeed if an air pollution model is to be applied on a large space domain by using fine grids then its discretization will always lead to huge computational problems Assume for example that the space domain is discretized by using a 480 480 grid and that the number of chemical species studied by the model is 35 Then several systems of ordinary differential equations containing 8064000 equations have to be treated at every time step the number of time steps being typically several thousand If a three dimensional version of the same air pollution model is to be used then the above figure must be multiplied by the number of layers It is extremely

difficult to treat such large computational problems even when the fastest computers that are available at present are used There is an additional great difficulty which is very often underestimated or even neglected when large application packages are moved from sequential computers to modern parallel machines The high speed computers have normally a very complicated memory architecture and therefore the task of producing an efficient code for the particular high speed computer that is available is both extremely hard and very laborious The use of standard parallelization tools in the solution of the problems sketched above is discussed in this paper Results obtained on different types of parallel computers are given It is demonstrated that the new efficient parallel algorithms allow us to solve more problems and bigger problems

Mathematical Problems in Meteorological Modelling András Bátkai, Petra Csomós, István Faragó, András Horányi, Gabriella Szépszó, 2016-11-08 This book deals with mathematical problems arising in the context of meteorological modelling It gathers and presents some of the most interesting and important issues from the interaction of mathematics and meteorology It is unique in that it features contributions on topics like data assimilation ensemble prediction numerical methods and transport modelling from both mathematical and meteorological perspectives The derivation and solution of all kinds of numerical prediction models require the application of results from various mathematical fields The present volume is divided into three parts moving from mathematical and numerical problems through air quality modelling to advanced applications in data assimilation and probabilistic forecasting The book arose from the workshop Mathematical Problems in Meteorological Modelling held in Budapest in May 2014 and organized by the ECMI Special Interest Group on Numerical Weather Prediction Its main objective is to highlight the beauty of the development fields discussed to demonstrate their mathematical complexity and more importantly to encourage mathematicians to contribute to the further success of such practical applications as weather forecasting and climate change projections Written by leading experts in the field the book provides an attractive and diverse introduction to areas in which mathematicians and modellers from the meteorological community can cooperate and help each other solve the problems that operational weather centres face now and in the near future Readers engaged in meteorological research will become more familiar with the corresponding mathematical background while mathematicians working in numerical analysis partial differential equations or stochastic analysis will be introduced to further application fields of their research area and will find stimulation and motivation for their future research work

Computational Science - ICCS 2001 Vassil N. Alexandrov, Jack J. Dongarra, Benjoe A. Juliano, Rene S. Renner, C.J. Kenneth Tan, 2003-05-15 LNCS volumes 2073 and 2074 contain the proceedings of the International Conference on Computational Science ICCS 2001 held in San Francisco California May 27 31 2001 The two volumes consist of more than 230 contributed and invited papers that reflect the aims of the conference to bring together researchers and scientists from mathematics and computer science as basic computing disciplines researchers from various application areas who are pioneering advanced application of computational methods to sciences such as physics chemistry life sciences and

engineering arts and humanitarian fields along with software developers and vendors to discuss problems and solutions in the area to identify new issues and to shape future directions for research as well as to help industrial users apply various advanced computational techniques

Advanced Computing in Industrial Mathematics Ivan Georgiev, Hristo Kostadinov, Elena Lilkova, 2025-03-22 This book gathers the peer reviewed proceedings of the 16th Annual Meeting of the Bulgarian Section of the Society for Industrial and Applied Mathematics BGSIAM 21 held in Sofia Bulgaria The general theme of BGSIAM 21 was industrial and applied mathematics with particular focus on mathematical physics numerical analysis high performance computing optimization and control mathematical biology stochastic modeling machine learning digitization and imaging advanced computing in environmental biomedical and engineering applications

Computational and Numerical Challenges in Environmental Modelling Zahari Zlatev, Ivan Dimov, 2006-05-02 Many large mathematical models not only models arising and used in environmental studies are described by systems of partial differential equations The discretization of the spatial derivatives in such models leads to the solution of very large systems of ordinary differential equations These systems contain many millions of equations and have to be handled over large time intervals by applying many time steps up to several hundred thousand time steps Furthermore many scenarios are as a rule to be run This explains the fact that the computational tasks in this situation are enormous Therefore it is necessary to select fast numerical methods to develop parallel codes and what is most important when the problems solved are very large to organize the computational process in a proper way The last item which is very often underestimated but let us re iterate which is very important is the major topic of this book In fact the proper organization of the computational process can be viewed as a preparation of templates which can be used with different numerical methods and different parallel devices The development of such templates is described in the book It is also demonstrated that many comprehensive environmental studies can successfully be carried out when the computations are correctly organized Thus this book will help the reader to understand better that while a it is very important to select fast numerical methods as well as b it is very important to develop parallel codes this will not be sufficient when the problems solved are really very large In the latter case it is also crucial to exploit better the computer architecture by organizing properly the computational process Use of templates in connection with the treatment of very large models Performance of comprehensive environmental studies Obtaining reliable and robust information about pollution levels Studying the impact of future climatic changes on high pollution levels Investigating trends related to critical levels of pollution

Handbook of Massive Data Sets James Abello, Panos M. Pardalos, Mauricio G.C. Resende, 2013-12-21 The proliferation of massive data sets brings with it a series of special computational challenges This data avalanche arises in a wide range of scientific and commercial applications With advances in computer and information technologies many of these challenges are beginning to be addressed by diverse inter disciplinary groups that include computer scientists mathematicians statisticians and engineers working in close cooperation with application domain experts High profile

applications include astrophysics bio technology demographics finance geographical information systems government medicine telecommunications the environment and the internet John R Tucker of the Board on Mathematical Sciences has stated My interest in this problem Massive Data Sets is that I see it as the most important cross cutting problem for the mathematical sciences in practical problem solving for the next decade because it is so pervasive The Handbook of Massive Data Sets is comprised of articles written by experts on selected topics that deal with some major aspect of massive data sets It contains chapters on information retrieval both in the internet and in the traditional sense web crawlers massive graphs string processing data compression clustering methods wavelets optimization external memory algorithms and data structures the US national cluster project high performance computing data warehouses data cubes semi structured data data squashing data quality billing in the large fraud detection and data processing in astrophysics air pollution biomolecular data earth observation and the environment

Applied Parallel Computing Jack Dongarra, Kaj Madsen, Jerzy Wasniewski, 2006-02-27 This book constitutes the refereed proceedings of the 7th International Conference on Applied Parallel Computing PARA 2004 held in June 2004 The 118 revised full papers presented together with five invited lectures and 15 contributed talks were carefully reviewed and selected for inclusion in the proceedings The papers are organized in topical sections

Applied Parallel Computing, 2004

Large Scale Computations in Air Pollution Modelling Zahari Zlatev, Jorgen Brandt, Peter J H Builtjes, 1999-03-31 The protection of the environment is one of the most important problems facing us today Reliable and robust strategies for keeping pollution caused by harmful chemicals under safe levels have to be developed and used routinely Large mathematical models incorporating all important physical and chemical processes can solve this task but the computational burden is huge The papers presented here describe some of the difficult problems that have to be solved during the development of large scale air pollution models and different ways to solve them The work involves combined research by specialists in the fields of environmental modelling numerical analysis and scientific computing Further if models are to run in real time which may be vital in the case of accidental hazardous releases then new and efficient methods that harness the potential power of parallel supercomputers must be developed so that actual computing speed starts to approach the maximum available performance The articles are understandable by specialists in the field of air pollution modelling as well as specialists in the many other related areas

Advances in Air Pollution Modeling for Environmental Security István Faragó, Krassimir Georgiev, Ágnes Havasi, 2005-07-14 The protection of our environment is one of the major problems in the society More and more important physical and chemical mechanisms are to be added to the air pollution models Moreover new reliable and robust control strategies for keeping the pollution caused by harmful compounds under certain safe levels have to be developed and used in a routine way Well based and correctly analyzed large mathematical models can successfully be used to solve this task The use of such models leads to the treatment of huge computational tasks The efficient solution of such problems requires combined research from specialists working in different

fields The aim of the NATO Advanced Research Workshop NATO ARW entitled Advances in Air Pollution Modeling for Environmental Security was to invite specialists from all areas related to large scale air pollution modeling and to exchange information and plans for future actions towards improving the reliability and the scope of application of the existing air pollution models and tools This ARW was planned to be an interdisciplinary event which provided a forum for discussions between physicists meteorologists chemists computer scientists and specialists in numerical analysis about different ways for improving the performance and the quality of the results of different air pollution models

Parallel Numerical Linear Algebra J. J. Dongarra, Erricos John Kontoghiorghes, 2001 Contents A Java Based Distributed Debugger Supporting MPI and PVM On Encoding Neural Networks to Estimate the Atmospheric Point Spread Function in a Parallel Environment A Comparison of Parallel Solvers for Diagonally Dominant and General Narrow Banded Linear Systems Mapping Strategies in Data Parallel Programming Models the Projection Methods Parallel Multiplication of a Vector by a Kronecker Product of Matrices Parallel Sparse Matrix Algorithms for Air Pollution Models Band Preconditioners Application to Preconditioned Conjugate Gradient Methods on Parallel Computers

Time-Integration Algorithms for the Computer Treatment of the Horizontal Advection in Air Pollution Models Zahari Zlatev, 2018 The horizontal advection is one of the most important physical processes in an air pollution model While it is clear how to describe mathematically this process the computer treatment of the arising first order partial differential equation PDE causes great difficulties It is assumed that the spatial derivatives in this equation are discretized either by finite differences or by finite elements This results in a very large system of ordinary differential equations ODEs The numerical treatment of this system of ODEs is based on the application of a set of predictor corrector PC schemes with different absolute stability properties The PC schemes can be varied during the time integration Schemes which are computationally cheaper are selected when the stability requirements are not stringent If the stability requirements are stringent then schemes that are more time consuming but also have better stability properties are chosen Some norms of the wind velocity vectors are calculated and used in the check of the stability requirements Reductions of the time step size are avoided or at least reduced considerably when the PC schemes are appropriately varied This leads to an increase of the efficiency of the computations in the treatment of large scale air pollution models The procedure is rather general and can also be used in the computer treatment of other large scale problems arising in different fields of science and engineering

Numerical Analysis and Its Applications, 2004

Practical Parallel Computing Marcin Paprzycki, 2001 These ten papers represent a range of applications for the practical use of parallel computing They address large scale high performance applications data transfer and storage cost minimisation two stroke engine applications large air pollution models parallel global aircraft configuration design parallel execution time analysis parallel randomised heuristics the analysis of complex waveguide circuits reading database copy and business process re engineering

A New Grid-based Mobile Source Emissions Inventory Model Yi Zheng, 2003

Meteorologische Zeitschrift ,2000 Computational Methods in Applied Mathematics ,2002 **Conference**
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