SIAM

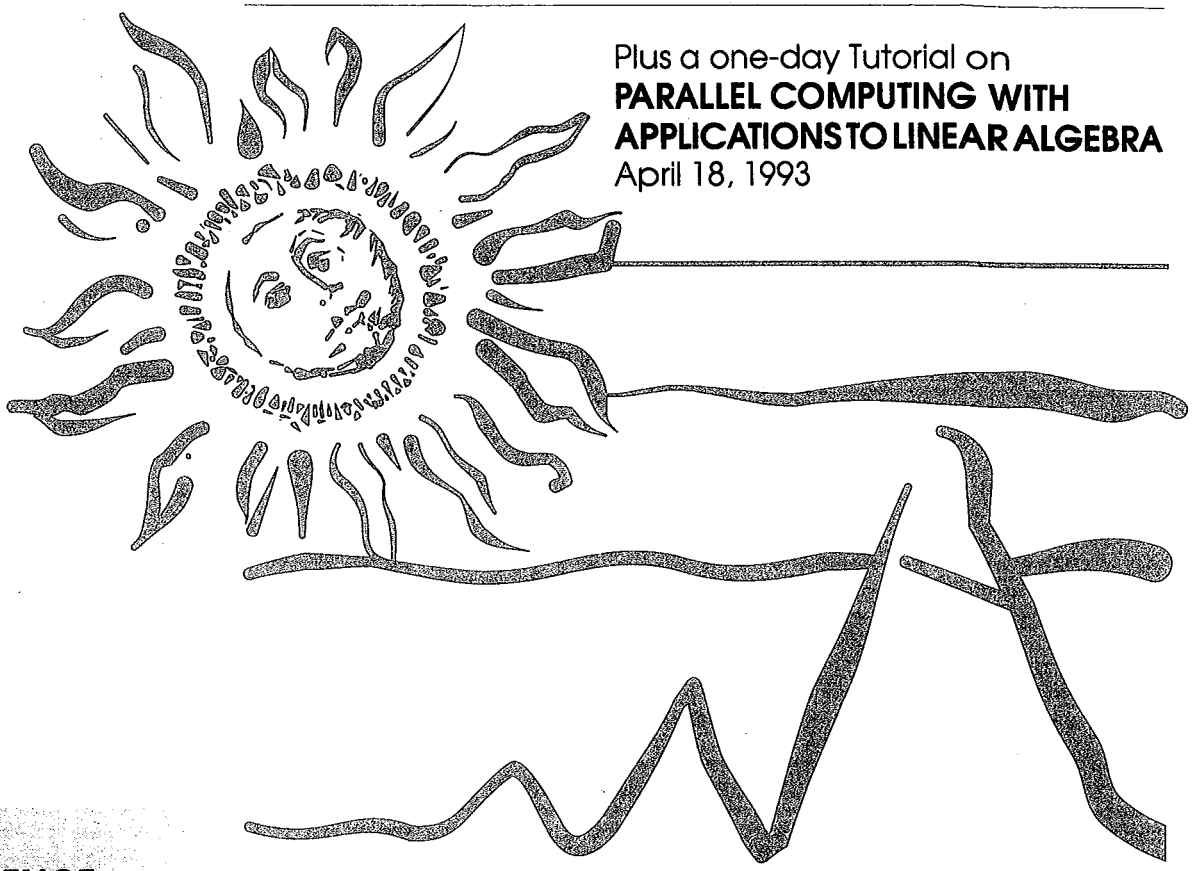
CONFERENCE PROGRAM

Society for Industrial and Applied Mathematics

SIAM Conference on Mathematical and Computational Issues in the GEOSCIENCES

APRIL 19 - 21, 1993

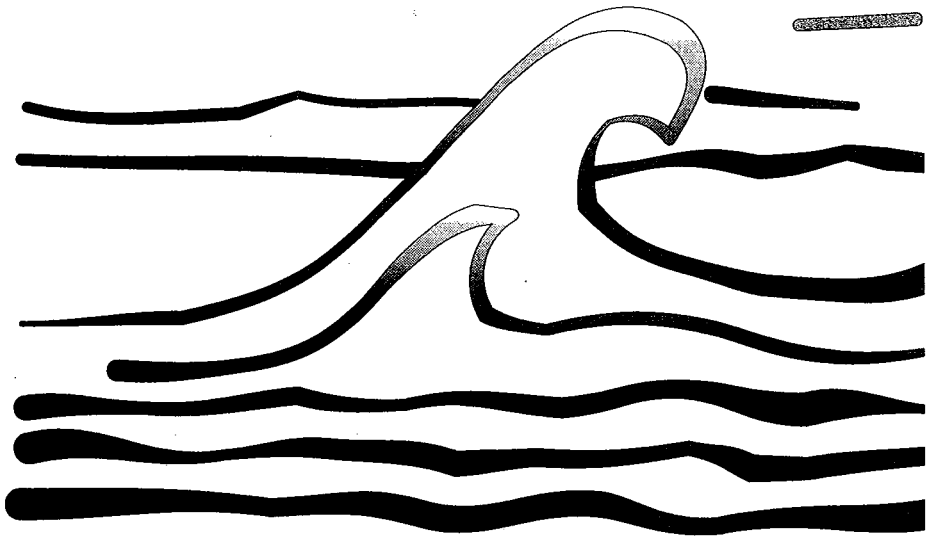
Sponsored by SIAM Activity Group on Geosciences



Plus a one-day Tutorial on
PARALLEL COMPUTING WITH APPLICATIONS TO LINEAR ALGEBRA
April 18, 1993

CONFERENCE THEMES

Hydrology
Reservoir Engineering
Porous Media
Seismic Imaging
Flow and Transport
Geochemical Systems
Oceanography
Parallel Computing
Atmospheric Science
Ecology/Environment
Characterization



HYATT REGENCY HOUSTON ◦ HOUSTON, TEXAS

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DEADLINE DATES

Hotel Reservations
Monday, March 29, 1993

Conference Preregistration
Monday, April 5, 1993

ORGANIZING COMMITTEE

James G. Glimm (Chair)
Department of Applied Mathematics and Statistics
State University of New York, Stony Brook

Michael Celia
Department of Civil Engineering
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Chevron Oil Field Research Company
La Habra, CA

Richard E. Ewing
Institute for Scientific Computation
Texas A&M University, College Station

Ronald F. Peierls
Brookhaven National Laboratory
Upton, NY

William W. Symes
Department of Mathematical Sciences
Rice University

Mary F. Wheeler
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Rice University

FUNDING AGENCIES

SIAM is conducting this conference with the partial support of the National Science Foundation and the Army Research Office sponsored Center for the Analysis of Nonlinear Systems at the University at Stony Brook.

TUTORIAL

Tutorial on Parallel Computing with Applications to Linear Algebra

April 18, 1993

Organizers: Todd Arbogast and Clint N. Dawson
Department of Mathematical Sciences, Rice University

Tutorial Description and Objectives

The use of parallel computers to solve large-scale problems arising in the geosciences is an area of growing interest. In the last several years, many new algorithms have been developed and current algorithms have been adapted for use on parallel machines. This tutorial will cover the basic aspects of parallel computing including architectures and performance issues, and then concentrate on parallel computation in the solution of linear algebraic systems and eigenvalue problems, and in the numerical solution of partial differential equations.

Among the topics to be discussed: Block algorithms-BLAS, LAPACK, algorithms and software for large sparse linear systems and eigenvalue problems, domain decomposition for numerical solution of partial differential equations, discussion of available domain decomposition software, and how to use networks of workstations as parallel computers.

Who Should Attend?

Academic, industrial, and government researchers who are interested in the use of parallel computers to solve geoscience problems.

Recommended Background

A basic knowledge of computational linear algebra (Gaussian elimination, eigenvalues and eigenvectors, iterative methods), as well as some knowledge of partial differential equations.

Lecturers

William Gropp received his Ph.D. in computer science from Stanford University in 1982. He was an assistant and associate professor of computer science at Yale University from 1982 until 1990; he is currently a computer scientist at the Argonne National Laboratory. Dr. Gropp has been working on parallel methods for PDEs since 1984, when he used a cluster of Apollo workstations. His most recent work is on parallel domain decomposition methods for both high-end parallel computers (such as the Intel Touchstone Delta) and for clusters of workstations.

David Keyes is an associate professor in the Department of Mechanical Engineering at Yale University, a regular visitor at ICASE and Argonne National Laboratory, and a consultant at UTRCC and Boeing. His principal research interests are in parallel computational fluid mechanics and combustion. He received his Ph.D. in applied mathematics from Harvard University in 1984.

Danny Sorensen received his B.S. in mathematics from University of California, Davis in 1972 and his Ph.D. in mathematics from University of California, San Diego in 1977. He was an assistant professor of mathematics at University of Kentucky from 1977-1980. He then joined the mathematics and computer science division of Argonne National Laboratory where he became a senior computer scientist. He joined the faculty of Rice University in 1989. Dr. Sorensen was one of the founders of the Advanced Computing Research Facility at Argonne National Laboratory. This facility was one of the first to provide public access to a variety of parallel computers. His research interests are in computational mathematics with emphasis on numerical linear algebra and parallel computing. He has also worked extensively in the area of nonlinear numerical optimization. His current research activities involve parallel iterative techniques for the solution of large scale algebraic eigenvalue problems.

Program

9:30 AM	**Parallel Architectures and Performance Issues** Danny Sorensen
10:15 AM	**Coffee**
10:45 AM	**Linear Algebra on Vector and Parallel Computers** Danny Sorensen
11:30 AM	**Lunch**
1:00 PM	**Domain Decomposition Methods for Parallel Computation: Convergence and Complexity** David Keyes
2:30 PM	**Coffee**
3:00 PM	**Domain Decomposition Methods for Parallel Computation: Design and Implementation** William Gropp
4:30 PM	**Discussion**
5:00 PM	**Adjourn**

Tutorial Registration Fees*

	SIAM Member	Non-Member	Student
Preregistration	$120	$135	$55
Registration	$135	$155	$75

*Registration fee for the tutorial includes preprints, coffee and lunch. Preprints for the tutorial will be distributed upon check in at the registration desk.

The tutorial will be located in Regency Room and the luncheon will be served in Arboretum 2. Coffee breaks will take place in the Regency Foyer.

PROGRAM OVERVIEW

Following are subject classifications for the sessions. The codes in parentheses designate session type and number. The session types are invited presentations (IP), contributed presentations (CP) and minisymposium (MS).

Atmospheric Modeling
Atmospheric Modeling (CP8, page 12)
Climate Stability and Nonlinear Dynamics (IP6, page 11)
Dynamics of Urban and Regional Air Pollution (IP3, page 6)
Poster Session (page 10)

Environmental Models
Biodegradation, Dissolution and Other Forms of Reactive Flow and Transport (MS25, page 11)
Dispersal of Pollutants in the Environment (MS3, page 5)
Modeling Fluid Flow and Contaminant Transport in Heterogeneous Porous Media (MS4, page 5)
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Simulation of NAPL Groundwater Contamination (MS19, page 10)
Simulation of Porous Media Flows and Contaminant Transport in Geological Waste Repositories, Parts I and II (MS14, page 8; MS21, page 10)

Geochemical Models
Multi-Scale Unstable Geochemical Dynamics: Homogenization and Bifurcation Approaches to Problems in Petroleum Exploration and Production (IP2, page 5)
Nonlinear Phenomena in Geochemical Systems: Homogenization, Bifurcation, and Numerical Approaches, Parts I and II (MS5, page 6; MS10, page 7)

Heterogeneities and Parameter Estimation
A Review of Current Trends in Petroleum Reservoir Simulation and Assessment of the Impacts on Oil Recovery (IP7, page 11)
Dispersal of Pollutants in the Environment (MS3, page 5)
Homogenization for Flow and Transport through Porous Media (MS15, page 9)
Macrodispersion for Flow in Porous Media (IP8, page 12)
Optimization and Parameter Estimation (MS7, page 6)
Parameter Identification I and II (CP1, page 6; CP12, page 13)
Poster Session (page 10)
Predicting Versus Interpreting: A Survey of Oil Recovery Modeling (IP5, page 8)
Reservoir Characterization (MS23, page 11)
Transport in Media Which Possess Evolving Heterogeneity (MS27, page 12)

Hydrology
Computational Advances in Modeling of Surface Water Flow (MS8, page 7)
The Role of Computational Science in Groundwater Hydrology (IP1, page 5)

Numerical Methods
Adaptive Methods (CP11, page 13)
Efficient and Accurate Determination of Fluid Velocities (MS16, page 9)
Numerical Algorithms for Modeling Transport Phenomena in Porous Media, Part 2 of 2 (MS26, page 12)
Numerical Techniques for Computation of Ground Water Flows (MS9, page 7)
Parallel Domain Decomposition and Multigrid Techniques (MS1, page 5)
Predicting Versus Interpreting: A Survey of Oil Recovery Modeling (IP5, page 8)
Porous Media Modeling I (CP5, page 9)

Oceanography
High Resolution Ocean Modeling (MS13, page 8)
Oceanography (CP10, page 13)
Poster Session (page 10)
The Impact of Ocean Waves on Coastal Regions (MS18, page 10)

Optimization
Global Optimization Methods in Geosciences (MS2, page 5)
Modeling and Management (CP2, page 6)
Optimization and Parameter Estimation Problems in Porous Media (MS7, page 6)

Parallel Computing
Efficient and Accurate Determination of Fluid Velocities Parallel Algorithms (CP9, page 12)
Parallel Computation in Applications (MS6, page 6)
Parallel Domain Decomposition and Multigrid Techniques (MS1, page 5)
Vectorization and Parallelization in Reservoir Simulation (MS11, page 8)

Seismic Inversion
Recent Progress in Seismic Imaging for Reservoir Analysis (IP4, page 8)
Seismic and Inverse Imaging (CP4, page 7)
Seismic Imaging and Inversion: Resolution, Geological Constraints, and Algorithms, Parts 1 and 2 (MS12, page 8; MS17, page 10)
Wavelet-Based Methods in the Geosciences (MS29, page 13)

Transport in Porous Media
Hyperbolic Systems in Porous Media Flow (MS20, page 10)
Numerical Algorithms for Modeling Transport Phenomena in Porous Media Parts 1 and 2 (MS22, page 11; MS26, page 12)
Numerical Techniques for Computation of Ground Water Flows (MS9, page 7)
Porous Media Modeling I and II (CP3, page 7; CP6, page 9)
Some Aspects of Porous Media Research in the Netherlands (MS24, page 11)
Reservoir Simulation Research at INTEVEP, S.A. (MS28, page 12)
Transport in Porous Media (CP7, page 10)
Transport in Media Which Possess Evolving Heterogeneity (MS27, page 12)

Saturday, April 17

6:00 PM-8:00 PM **Registration for Tutorial opens**
Regency Foyer

Sunday, April 18

7:30 AM-4:00 PM **Registration for Tutorial opens**
Regency Foyer

9:00 AM-5:00 PM **Tutorial**
Regency Room

6:00 PM-8:00 PM **Registration for Conference opens**
Regency Foyer

6:30 PM-8:30 PM **Welcoming Reception**
Window Box Room

Monday Morning, April 19

7:30 **Registration opens**
Regency Foyer

8:20 **Opening Remarks / James G. Glimm**
Regency Room

8:30 **IP1** **The Role of Computational Sciences in Groundwater Hydrology**
Michael A. Celia
Regency Room

9:15 **IP2** **Multi-Scale Unstable Geochemical Dynamics: Homogenization and Bifurcation Approaches to Problems in Petroleum Exploration and Production**
Peter J. Ortoleva
Regency Room

10:00 **Coffee** / *Window Box*

10:30 **Concurrent Sessions**

MS1 **Parallel Domain Decomposition and Multigrid Techniques**
Organizers: Todd Arbogast and Clint N. Dawson
Regency Room

MS2 **Global Optimization Methods in Geosciences**
Organizers: Allan Gutjahr and Ahmed Ouenes
Arboretum 1 Room

MS3 **Dispersal of Pollutants in the Environment**
Organizers: William G. Pritchard and Paul J. Sullivan
Arboretum 2 Room

MS4 **Modeling Fluid Flow and Contaminant Transport in Heterogeneous Porous Media**
Organizer: Michael A. Celia
Arboretum 3 Room

MS5 **Nonlinear Phenomena in Geochemical Systems: Homogenization, Bifurcation, and Numerical Approaches (Part 1 of 2)**
Peter J. Ortoleva
Arboretum 4 Room

CP1 **Parameter Identification I**
Arboretum 5 Room

CP2 **Modeling and Management**
Redbud Room

Monday Afternoon, April 19

12:30 **Lunch**

2:00 **IP3** **Dynamics of Urban and Regional Air Pollution**
John H. Seinfeld
Regency Room

2:45 **Coffee**/ *Window Box*

3:15 **Concurrent Sessions**

MS6 **Parallel Computation in Applications**
Organizers: Todd Arbogast and Clint N. Dawson
Regency Room

MS7 **Optimization and Parameter Estimation Problems in Porous Media**
Organizers: Daene C. McKinney and Marcelo Ramé
Arboretum 1 Room

MS8 **Computational Advances in Modeling of Surface Water Flow**
Organizer: William G. Gray
Arboretum 2 Room

MS9 **Numerical Techniques for Computation of Ground Water Flows**
Organizers: Kenneth Clark and Jeffrey Holland
Arboretum 3 Room

MS10 **Nonlinear Phenomena in Geochemical Systems: Homogenization, Bifurcation, and Numerical Approaches (Part 2 of 2)**
Organizer: Peter J. Ortoleva
Arboretum 4 Room

CP3 **Porous Media Modeling I**
Arboretum 5 Room

CP4 **Seismic and Inverse Imaging**
Redbud Room

6:00 **Meet-and-Greet Hour** / *Window Box*

Tuesday Morning, April 20

7:30 **Registration opens**
Regency Foyer

8:30 **IP4** **Recent Progress in Seismic Imaging for Reservoir Analysis**
James H. Justice
Regency Foyer

9:15 **IP5** **Predicting Versus Interpreting: A Survey of Oil Recovery Modeling**
Larry W. Lake
Regency Room

10:00 **Coffee** / *Window Box*

10:30 **Concurrent Sessions**

MS11 **Vectorization and Parallelization in Reservoir Simulation**
Organizers: Richard T. Mifflin and Kamy Sepehrnoori
Regency Room

MS12 **Seismic Imaging and Inversion: Resolution, Geological Constraints, and Algorithms (Part 1 of 2)**
William W. Symes
Arboretum 1 Room

MS13 **High Resolution Ocean Modeling**
Organizers: Patrick L. Roache and David E. Dietrich
Arboretum 2 Room

MS14 **Simulation of Porous Media Flows and Contaminant Transport in Geological Waste Repositories (Part 1 of 2)**
Organizers: Thomas H. Robey and Stanly Steinberg
Arboretum 3 Room

MS15 **Homogenization for Flow and Transport through Porous Media**
Organizer: Ulrich Hornung
Arboretum Room 4

CP5 **Finite Element Methods**
Arboretum 5 Room

CP6 **Modeling II**
Ebony Room

Tuesday Afternoon, April 20

12:30 **Lunch**

2:00 **Panel Discussion on Recognition and Rewards in Mathematics**
Discussants: Richard A. Tapia and J. E. Dennis, Jr.
Regency Room

2:45 **Coffee**/ *Window Box*

3:15 **Concurrent Sessions**

MS16 **Efficient and Accurate Determination of Fluid Velocities**
Organizer: Richard E. Ewing
Regency Room

MS17 **Seismic Imaging and Inversion: Resolution, Geological Constraints and Algorithms (Part 2 of 2)**
Organizer: William W. Symes
Arboretum 1 Room

MS18 **The Impact of Ocean Waves on Coastal Regions**
Organizers: Joseph L. Hammack and William G. Pritchard
Arboretum 2 Room

MS19 **Simulation of NAPL Groundwater Contamination**
Organizer: Peter A. Forsyth
Arboretum 3 Room

MS20 **Hyperbolic Systems in Porous Media Flow**
Organizer: Ragnar Winther
Arboretum 4 Room

MS21 **Simulation of Porous Media Flows and Contaminant Transport in Geological Waste Repositories (Part 2 of 2)**
Organizers: Thomas H. Robey and Stanly Steinberg
Ebony Room

CP7 **Transport in Porous Media**
Arboretum 5 Room

Poster Session 1
Window Box

8:00 PM **Business Meeting**
SIAM Activity Group on Geosciences
Regency Room

Wednesday Morning, April 21

7:30 **Registration opens**

8:30 **IP6** **Climate Stability and Nonlinear Dynamics**
Michael Ghil
Regency Room

9:15 **IP7** **A Review of Current Trends in Petroleum Reservoir Simulation and Assessment of the Impacts on Oil Recovery**
F. John Fayers and T. A. Hewett
Regency Room

10:00 **Coffee** / *Window Box*

10:30 **Concurrent Sessions**

MS22 **Numerical Algorithms for Modeling Transport Phenomena in Porous Media (Part 1 of 2)**
Organizer: Mary F. Wheeler
Regency Room

MS23 **Reservoir Characterization**
Organizers: Richard T. Mifflin and Kamy Sepehrnoori
Arboretum 1 Room

MS24 **Some Aspects of Porous Media Research in the Netherlands**
Organizer: C. J. van Duijn
Arboretum 2 Room

MS25 **Biodegradation, Dissolution and Other Forms of Reactive Flow and Transport**
Organizer: Kyle Roberson
Arboretum 3 Room

CP8 **Atmospheric Modeling**
Arboretum 4 Room

CP9 **Parallel Algorithms**
Arboretum 5 Room

Poster Session 1 (continued)
Window Box

Wednesday Afternoon, April 21

12:30 **Lunch**

2:00 **IP8** **Macrodispersion for Flow in Porous Media**
James G. Glimm
Regency Room

2:45 **Coffee**
Window Box

3:15 **Concurrent Sessions**

MS26 **Numerical Algorithms for Modeling Transport Phenomena in Porous Media (Part 2 of 2)**
Organizer: Mary F. Wheeler
Regency Room

MS27 **Transport in Media Which Possess Evolving Heterogeneity**
Organizer: John H. Cushman
Arboretum 1 Room

MS28 **Reservoir Simulation Research at INTEVEP, S.A.**
Organizers: Saul Buitrago and Enrique Rodriguez
Arboretum 2 Room

MS29 **Wavelet-Based Methods in the Geosciences**
Organizers: Siamak Hassanzadeh and Sergio Zarantonello
Arboretum 3 Room

CP10 **Oceanography**
Arboretum 4 Room

CP11 **Adaptive Methods**
Arboretum 5 Room

CP12 **Parameter Identification II**
Ebony Room

6:00 **Conference adjourns**

MONDAY MORNING, APRIL 19

7:30/Regency Foyer

Registration opens

8:20/Regency Room

Opening Remarks

James G. Glimm, State University of New York, Stony Brook

8:30/Regency Room

IP1/Chair: Richard E. Ewing,
Texas A&M University, College Station

The Role of Computational Science in Groundwater Hydrology

In groundwater hydrology, numerical models are often used to analyze contaminant transport problems at specific field sites. However, with the continuing development of very powerful computer hardware, numerical simulation is now being viewed in a more scientific role: simulations can be performed in lieu of certain physical experiments. This makes it possible to study a wide range of problems, for example the influence of material heterogeneities on transport parameters. This type of computational science requires highly accurate and efficient numerical algorithms but also requires the analyst to understand physical aspects of the problem such as scales of motion and measurement techniques. Example calculations involving multi-phase flow and transport demonstrate how computational science can be used to determine effective large-scale parameters, which cannot be measured physically, based on quantities that can be measured at smaller scales.

Michael A. Celia
Department of Civil Engineering
Princeton University

9:15/Regency Room

IP2/Chair: James G. Glimm,
State University of New York, Stony Brook

Multi-Scale Unstable Geochemical Dynamics: Homogenization and Bifurcation Approaches to Problems in Petroleum Exploration and Production

The evolution of a sedimentary basin (100 km-scale in width and 10 km-scale in depth) involves the interplay of many strongly coupled reaction, transport and mechanical processes. These processes operate on length scales from the submeter to basin wide. They involve symmetry-breaking instabilities that lead to petroleum-trapping banded rock, kilometer-scale hydrologic compartments and submeter-scale crystal growth patterns. Homogenization theory allows us to model the multiple-scale, unstable dynamical system. As a result states of the basin can be predicted that are self-organized in space and are oscillatory in time. The speaker will present illustrative examples of application of bifurcation theory and homogenization theory and of related computational algorithms. He will consider applications to problems in petroleum exploration and production.

Peter J. Ortoleva
Department of Chemistry
Indiana University, Bloomington

10:00/Window Box

Coffee

10:30 AM-12:30 PM

Concurrent Sessions

MS1/Regency Room

Parallel Domain Decomposition and Multigrid Techniques

This session will focus on the parallel solution of partial differential equations that arise in geoscientific applications. These problems tend to be very large and highly ill conditioned, so the goal is to find ways to solve them effectively on large, massively parallel machines. The convergence properties of the solution algorithm must scale well to many processors; otherwise, the cost of communications overwhelms the computing power of the machine and additional processors do not reduce the run-time. Two current techniques for solving these problems in parallel include domain decomposition and multigrid. The formulation and implemention of these techniques in a parallel environment will be explored.

Organizers: Todd Arbogast and Clint N. Dawson
Rice University

10:30 Domain Decomposition Methods for the Solution of PDE's
William D. Gropp, Argonne National Laboratory

11:00 Noniterative Domain Decomposition for Second-Order Hyperbolic and Parabolic Problems
Todd F. Dupont, University of Chicago

11:30 Multilevel Projection Methods for Integral Conservation Laws
Stephen F. McCormick, University of Colorado, Denver

12:00 Parallel Multigrid Methods for Petroleum Reservoir Problems
Joel E. Dendy, Los Alamos National Laboratory

MS2/Arboretum 1

Global Optimization Methods in Geosciences

Many problems in geosciences have been successfully solved by using global optimization methods in general and Simulated Annealing Method (SAM) in particular. Innovative and successful approaches, in various applications, confirm the great potential of global optimization methods, especially in geosciences where the number of parameters to estimate is huge compared to conventional applications in science nd engineering.

In this minisymposium, the speakers will provide a global picture and the state-of-the-art in global optimization applied to geosciences, and discuss further applications and enhancements such as parallelization of the optimization methods for reducing the computational time.

Organizers: Allan Gutjahr and Ahmed Ouenes
New Mexico Institute of Mining and Technology

10:30 Global Optimization Methods in Petroleum and Gas Reservoir Engineering: Current Status and Future Perspectives
Ahmed Ouenes, Allan Gutjahr and Robert Lee, New Mexico Institute of Mining and Technology

11:00 Hydrologic Inversion Using Iterated Function Systems (IFS)
Christine Doughty, Jane C.S. Long, and Kevin Hestir, Lawrence Berkeley Laboratory

11:30 Geophysical Inversion Using Global Optimization
Sen Mrinal and Paul L. Stoffa, University of Texas, Austin

12:00 Generation of Markov Hydraulic Conductivity Field Realizations Using the CM-2 Machine
Suzan Colarullo, Allan Gutjahr, Fred Phillips and J. Matthew Davis, New Mexico Institute of Mining and Technology, and Bryan Travis, Los Alamos National Laboratory

MS3/Arboretum 2

Dispersal of Pollutants in the Environment

The challenge of developing mathematical models to provide predictive capability for the spreading and dilution of contaminants released in the complicated flows of the environment is formidable. In this session, the speakers will discuss the underlying theoretical difficulties and review the current generation of mathematical models. Because of the theoretical difficulties associated with the prediction of the concentration field of an environmental contaminant, it is crucial that detailed experimental validation be obtained for any proposed mathematical model. Aspects of such validation processes, along with some field data, will be discussed.

Organizers: William G. Pritchard, Penn State University, University Park, and Paul J. Sullivan, The University of Western Ontario, Canada

10:30 The Dilution of a Contaminant Spill in Environmental Flows
Paul J. Sullivan, Organizer

11:00 Fractal Interpretation of Particulate Dispersion
K.R. Sreenivasan, Yale University

11:30 Lidar Measurements of Plume Statistics
Torben Mikkelsen and Hans E. Jørgensen, Riso National Laboratory, Denmark

12:00 The Next Generation of Quantitative Models of Environmental Pollution
Philip Chatwin, University of Sheffield, United Kingdom

MS4/Arboretum 3

Modeling Fluid Flow and Contaminant Transport in Heterogeneous Porous Media

The speakers in this minisymposium will present methods currently being used to incorporate material heterogeneities into mathematical and numerical models of contaminant transport in the subsurface. They will discuss analytical and numerical approaches. The analytical techniques range from stochastic methods to spatial filtering, while the numerical methods range from pore-scale models of multiphase flow to large-scale continuum models of contaminant transport. The speakers will stress the importance of measurements and the systematic incorporation of data into the different models. Although this minisymposium focuses on groundwater contamination, the techniques presented are applicable to a wide range of porous media flow problems.

Organizer: Michael A. Celia
Princeton University

10:30 Field-Scale Transport Processes in Heterogeneous Aquifers
Lynn W. Gelhar, Massachusetts Institute of Technology

11:00 Monte Carlo Analysis of Nonreactive and Reactive Solute Transport in Three-Dimensional Heterogeneous Porous Media: Mean Displacement, Plume Spreading and Uncertainty
Edward A. Sudicky, University of Waterloo, Canada

11:30 Modeling the Large-Scale Dynamics of Fluid Flow in Heterogeneous Porous Media Using Spatial Filtering Theory
Roger Beckie, University of British Columbia, Canada, and Alvaro Aldama, Mexican Institute of Water Technology, Mexico

12:00 Pore-Scale Modeling of Multiphase Flow and Transport in Heterogeneous Porous Media
Harihar Rajaram, Lin A. Ferrand, Princeton University, and Michael A. Celia, Organizer

MS5/Arboretum 4

Nonlinear Phenomena in Geochemical Systems: Homogenization, Bifurcation, and Numerical Approaches (Part 1 of 2)

Reaction, transport and mechanical processes in geological systems may be strongly coupled and, as the underlying partial differential equations are nonlinear, lead to symmetry-breaking instabilities, temporal oscillation, propagating fronts and a host of other nonlinear phenomena. Such phenomena arise on both the geological and engineering time scales and play a central role in petroleum and mineral exploration and production and in environmental problems. The challenge is to delineate phenomena that can occur and predict the conditions favoring them. Their spatial complexity makes these systems ready but difficult problems for homogenization and numerical analysis.

Organizer: Peter J. Ortoleva
Indiana University, Bloomington

10:30 Geochemical Reaction-Transport Modeling on a Shared Memory, Multi-Processor System
Wei Chen, Silicon Graphics Computer Systems, Hudson, MA; Yueting Chen, Jun Mu, Indiana University Bloomington; and Peter J. Ortoleva, Organizer

11:00 Reactive Flows in Layered Porous Media: Homogenization and Morphological Stability
John Chadam, McMaster University, Canada; Peter J. Ortoleva, Organizer; A. Peirce, McMaster University, Canada; and J. Xin, University of Arizona

11:30 Mechanical and Chemical Instabilities Leading to Strain Localization in Sediments
Thomas Dewers, University of Oklahoma

CP1/Arboretum 5

Parameter Identification I

Chair: Daniel M. Tetzlaff, Texaco, Houston

10:30 Can Sedimentary Process Modeling Improve Reservoir Characterization?
Daniel M. Tetzlaff, Texaco, Houston

10:50 Predicting Permeability on a Basin Scale - An Impossible Task?
Marek Kacewicz, ARCO Exploration and Production Technology, Plano, TX

11:10 The Influence of Pore Size on Diffusion Coefficients Inside Porous Media: A Pore Scale Numerical Experiment
Chunhong Li, John L. Wilson, and Paul Hoffman, New Mexico Institute of Mining and Technology

11:30 Iterative Methods for Focussed Laterologs
John R. Lovell, Schlumberger-Doll Research, Ridgefield, CT

11:50 Pseudo Functions for Multi-Phase Flow: San Andres Application
Ekrem Kasap, University of Tulsa

12:10 Nonlocal Dispersion Theories
John H. Cushman, Purdue University, West Lafayette

CP2/Redbud Room

Modeling and Management

Chair: David E. Dougherty, University of Vermont

10:30 A Dual-Porosity Model of Compositional Flow in Fractured Reservoirs
Todd Arbogast, Rice University; *Zhangxin Chen,* AHPCRC/University of Minnesota, Minneapolis; and Jim Douglas, Jr., Purdue University, West Lafayette

10:50 The Mathematical Modeling of Gravitational Compaction in Sedimentary Basins
D. Marc Audet and Andrew C. Fowler, University of Oxford, United Kingdom

11:10 Carrier Facilitated Transport of Pollutants in Porous Media
Peter Knabner, Institut fur Angewandte Analysis und Stochastik, Germany

11:30 Excess Nitrogen, Environmental Policies and Farm-Level Profitability of Corn/Livestock Farms
Agapi Somwaru and Richard Nehring, ERS/USDA, Washington, DC

11:50 Optimal Multiple Management-Period Designs for Groundwater Remediation at LLNL Using Simulated Annealing
Donna M. Rizzo and David E. Dougherty, University of Vermont

12:10 Optimal Design of Pumping Schedules for Removal of Groundwater Pollutants
P. Mann and *H. Rasmussen,* University of Western Ontario, Canada

MONDAY AFTERNOON, APRIL 19

12:30-2:00
Lunch

2:00/Regency Room
IP3/Chair: Ronald F. Peierls, Brookhaven National Laboratory

Dynamics of Urban and Regional Air Pollution

Urban and regional air pollution is one of the world's most pervasive environmental problems. Mathematical models of atmospheric physics and chemistry relate source emissions to ambient pollutant concentrations in urban and regional areas occurring over episodes of several days duration. These models are based on solution of the species conservation equations over a three-dimensional atmospheric grid. Computational constraints have limited the extent of fundamental chemistry and physics that can be included in such models; for example, small particles (aerosols) and cloud and fog phases have not generally been incorporated in spite of their importance. Parallel computation offers promise to break the computational barrier to air pollution modeling. The speaker will present an overiew of the current status of urban and regional air pollution modeling.

John H. Seinfeld
Division of Engineering and Applied Science
California Institute of Technology

2:45/Window Box
Coffee

3:15-5:15 PM
Concurrent Sessions

MS6/Regency Room

Parallel Computation in Applications

In this session, various aspects of parallel, high-performance, geoscientific computing will be explored. The large and complex problems that arise in geoscientific applications are often solved on supercomputers. Massively parallel, distributed memory computers currently require that the programmer consider special programming problems, such as the solution of large, linear systems, mesh refinement, dynamic load balancing, and random field conditioning. Effective ways to handle such problems in parallel will be discussed.

Organizers: Todd Arbogast and Clint N. Dawson
Rice University

3:15 Domain Decomposition Linear Solvers of High Parallel Efficiency
Marcelo Ramé, Rice University; Clint Dawson, Organizer; Mary F. Wheeler, and Lawrence C. Cowsar, Rice University

3:45 Multigrid for Fully Time Dependent Multiphase Flow in Porous Media
Thomas W. Fogwell, International Technology Corp., Martinez, CA

4:15 Solving Free Boundary Seepage Problems on a Hypercube
John C. Bruch, Jr., University of California, Santa Barbara

4:45 Conditional Simulation and Estimation of Gauss-Markov Random Fields for Massively Parallel Architectures
Rachid Ababou , CEA-CEN, Saclay, France, and Amvrossios C. Bagtzoglou, Southwest Research Institute, San Antonio, TX

MS7/Arboretum 1

Optimization and Parameter Estimation Problems In Porous Media

Optimization and parameter estimation methods are used in porous media problems to determine values of model parameters in reservoir characterization and control variables in aquifer remediation design. In reservoir characterization problems, permeability and porosity fields are sought, constrained by laboratory tests and sparse field data. In aquifer remediation problems, well locations and pumping rates are sought, constrained by cleanup standards. Theoretical and computational aspects of these problems, such as nonconvexity and ill-posedness, make their solution challenging.

In this minisymposium, the speakers will address many of the current mathematical and computational challenges and problems in porous media optimization and parameter estimation problems. In recent years, solution techniques in this area have moved beyond the use of linear and nonlinear programming optimization techniques on sequential computers to the use of dynamic programming, optimal control, genetic algorithms and simulated annealing on parallel computers. The speakers will highlight and present these emerging areas of research.

Organizers: Daene C. McKinney, University of Texas, Austin and Marcelo Ramé, Rice University

3:15 Aquifer Parameter Identification by Simulated Annealing
James G. Uber, University of Cincinnati

3:45 Application of numerical Optimization to Remediation Design with Recharge at a Superfund Site
David P. Ahlfeld, University of Connecticut, George F. Pinder, University of Vermont, and R. H. Page, Environ Corporation, Princeton

4:15 **Nonlinear Programming Approaches to Parameter Identification for Flow in Porous Media**
John E. Dennis, Jr. and *Robert Michael Lewis,* Rice University

4:45 **Groundwater Optimization Using Genetic Algorithms**
Daene C. McKinney, Organizer, and Min-Der Lin, University of Texas, Austin

MS8/Arboretum 2

Computational Advances in Modeling of Surface Water Flow

Modeling of flow and circulation in tidal and non-tidal regions requires that the hyperbolic balance equations of mass and momentum be solved on the computer. The problem is made difficult by the nonlinearities in the flow, the large amounts of measured and computed data that must be manipulated, the complex geometries that must be discretized. As a result, efficient computational algorithms are needed. The speakers in this session will provide insight into the current directions and methodologies that are being employed in surface water flow.

Organizer: William G. Gray
University of Notre Dame

3:15 **Continuity Considerations in Shallow Water Modeling**
Randall L. Kolar and William G. Gray, University of Notre Dame

3:45 **A Predictive Model of Ocean Surface Currents**
Robert O. Reid, Texas A&M University

4:15 **Pre- and Post-processors for Surface Water Models: the Route Towards Expert Systems**
Antonio M. Baptista and Paul J. Turner, Oregon Graduate Institute of Science and Technology

4:45 **Assessing the Physics of Coastal Flow Models by Examining the Spectral Distribution of Non-linear Tides**
Rick A. Luettich, University of North Carolina, Chapel Hill and *Joannes J. Westerink,* University of Notre Dame

MS9/Arboretum 3

Numerical Techniques for Computation of Ground Water Flows

This minisymposium addresses both practical and theoretical problems in the computation of advective-diffusive flows arising in subsurface, porous media fluid transport. These problems are highly relevant in environmental science and engineering, for example, in the prediction and control of the flow of ground water contaminants or waste treatment. Realistic numerical simulations are extremely complicated due to severe nonlinearity, multiscale behavior, complicated geometry of the subsurface, and potential heterogeneity in permeability or porosity. The speakers in this minisymposium will discuss the development of new finite element/finite volume techniques, describe recently developed codes for groundwater transport, front-tracking methods for fine scale simulations of fluid instability, and discuss theoretical convergence questions for finite difference techniques for multiphase, heterogenous porous media flow problems.

Organizers: Kenneth Clark, US Army Research Office Research and Jeffrey Holland, US Army Waterways Experiment Station

3:15 **A Control-Volume Eulerian-Lagrangian Localized Adjoint Method for Simulation of Ground Water Flows**
Thomas F. Russell, University of Colorado, Denver and Richard W. Healy, U.S. Geological Survey, Denver

3:45 **The SECO Codes for Groundwater Flow, Particle Tracking, and Radionuclide Transport**
Patrick J. Roache, Ecodynamics, Albuquerque

4:15 **Discontinuity Resolution in Groundwater Flow**
W. Brent Lindquist, State University of New York, Stony Brook

4:45 **Multiscale Flow in Porous Media and Heterogeneities**
Jim Douglas, Jr., Purdue University, West Lafayette

MS10/Arboretum 4

Nonlinear Phenomena in Geochemical Systems: Homogenization, Bifurcation, and Numerical Approaches (Part 2 of 2)

(For description, see MS 5, Page 6)

Organizer: Peter J. Ortoleva
Indiana University, Bloomington

3:15 **Mechano-Chemical Pressure Seals in a Sedimentary Basin: A Computational Homogenization Approach**
Peter J. Ortoleva, Organizer

3:45 **Fluid Flow in Restricted Geometries: Scaling Behavior for Permeability**
Ping Sheng, Exxon Research and Engineering Company, Annandale, NJ

4:15 **Oscillatory Intracrystalline Zoning**
Jun Mu, Indiana University, Bloomington

CP3/Arboretum 5

Porous Media Modeling I

Chair: Bryan J. Travis, Los Alamos National Laboratory

3:15 **A Collocation-Based Interface Relaxation Domain Decomposition Algorithm to Solve Multiphase Flow and Contaminant Transport Problems in Porous Media**
Joseph Guarnaccia and George Pinder, University of Vermont

3:35 **Analytic Modeling of Three-Dimensional Flow in Unconfined Aquifers with Recharge**
Glenn Ledder and Vitaly Zlotnik, University of Nebraska, Lincoln

3:55 **Characteristics Analysis and Splitting Algorithm of Waterflooding in Naturally Fractured Reservoirs**
Zhi-an Luan, Petroleum University, Shan-Dong, People's Republic of China

4:15 **Integrated Core Analysis Study of a Sandstone Formation in Central Oman**
Mohammed Zubair Kalam, Sultan Qaboos University, Sultanate of Oman

4:35 **Convection in Tabular Magma Bodies Surrounded by Cold, Conducting Rock**
Bryan J. Travis and Greg A. Valentine, Los Alamos National Laboratory

4:55 **Analysis of Flow Regimes in Displacement Processes in Porous Media**
Y.C. Yortsos, University of Southern California

CP4/Redbud Room

Seismic and Inverse Imaging

Chair: William W. Symes, Rice University

3:15 **Inversion of Crosswell Seismology by Differential Semblance Analysis**
Hua Song and William W. Symes, Rice University

3:35 **Interactive 3D Seismic Data Analysis and Display on a Massively Parallel Distributed-Memory Machine**
Emilio Camahort, University of Texas, Austin; and Indranil Chakravarty, Schlumberger Laboratory for Computer Science

3:55 **Numerical Inversion for Three Dimensional Induced Polarization**
D. Moseley and *H. Rasmussen,* University of Western Ontario, Canada; and P. Forsyth, Jr., University of Waterloo, Canada

4:15 **An $N^{1.5}$ Algorithm for Solving the Volume Integral Equation**
Weng Cho Chew and Cai-Cheng Lu, University of Illinois, Urbana

4:35 **Nonlinear Interface Conditions in Modeling Elastic Wave Propagation**
John E. Spitler, University of Wyoming; James S. Sochacki, James Madison University; and Richard E. Ewing, Texas A&M University, College Station

4:55 **Waveform Inversion through MBTT Formulation**
Francois Clement, INRIA-Rocquencourt, France and Guy Chavent, University of Paris-Dauphine, France

5:15 **Initial Boundary Problems for Anisotropic Equations**
Yaroslav V. Kurylev, POMI, Russia and Purdue University

5:35 **Simultaneous Determination of Sounding Signal and Wave Propagation Velocity**
Alexander V. Avdeev, Computing Center, Novosibirsk, Russia

6:00 PM-7:00 PM/Window Box

Meet-and-Greet Hour

TUESDAY MORNING, APRIL 20

7:30/Regency Foyer

Registration opens

8:30/Regency Room

IP4/Chair: William W. Symes, Rice University

Recent Progress in Seismic Imaging for Reservoir Analysis

It is likely that the majority of the world's remaining oil and gas resources are to be found within the existing known reservoirs. New developments in seismic tomographic imaging and other interwell imaging technologies are beginning to permit detailed examination of the physical state of the reservoir with acceptable levels of resolution. These developments require sophisticated new mathematical approaches to imaging in diffractive media, modeling in poroelastic and viscoelastic media, and development of theoretical relationships that relate geophyscial measurements to rock properties and reservoir parameters. The speaker will discuss the challenging and exciting demands of some of these new areas of research and their impact on new developments in computational mathematics.

James H. Justice
Justice Associates, Inc.
Addison, Texas

9:15/Regency Room

IP5/Chair: Daniel M. Tetzlaff, Texaco, Houston

Predicting Versus Interpreting: A Survey of Oil Recovery Modeling

Numerical simulation, now the preeminent analytical tool in hydrocarbon recovery technology, has evolved through three phases: improving numerical accuracy, large-scale computing, and reservoir characterization. Because of the tremendous advances in computing hardware, simulation is on the brink of yet another phase, the efficiency phase. In the efficiency phase, it is recognized that the complexity (and expense) of a solution must be matched to the size of the problem being solved. Given the near-universal access to large-scale computing, the expense will be tied more to a practitioner's effort than to computing expenses.

In this presentation, the speaker will focus on aspects of numerical simulation that have been developed to bring about this efficiency: the use of predictive models, geostatistics, and the so-called hybrid streamtube approaches.

Larry W. Lake
Department of Petroleum Engineering
The University of Texas, Austin

10:00/Window Box

Coffee

10:30 AM-12:30 PM

Concurrent Sessions

MS11/Regency Room

Vectorization and Parallelization in Reservoir Simulation

The simulation of processes occurring in oil and gas reservoirs is computationally intensive. Depending upon the physics of the process being simulated, it may be important to resolve behavior at small length scales, due either to fluid behavior or to heterogeneity of rock properties. Increasing speeds of single-processor computers have not sufficiently improved resolution of these systems, which are still generally modeled using lumped properties. In this minisymposium, the speakers will address the issue of taking full advantage of new and emerging computer architectures to vectorize and/or parallelize reservoir simulation codes to allow more detailed processes to be modeled.

Organizers: Richard T. Mifflin, Exxon Production Research Co., Houston, and Kamy Sepehrnoori, University of Texas, Austin

10:30 Seismic Scale Reservoir Simulation on the Connection Machine
Kenneth M. Brantferger and Bret L. Beckner, Mobil Exploration and Production Technical Center, Dallas

11:00 Vectorizing and Parallel-Processing the Linear Equation Solver for the Local-Grid-Refinement Reservoir Simulation Model
Mark C.H. Chien and D. R. Jones, Chevron Petroleum Technology Company, La Habra, CA

11:30 Parallel Reservoir Simulation
Philip T. Keenan, Rice University, and Jon Flower, ParaSoft Corporation, Pasadena, CA

12:00 A Parallel Chemical Flood Simulator: Investigation on Distributed Memory Processors
Marcelo Ramé, Todd Arbogast, Clint N. Dawson and Mary F. Wheeler, Rice University

MS12/Arboretum 1

Seismic Imaging and Inversion: Resolution, Geological Constraints, and Algorithms (Part 1 of 2)

Seismology provides the most detailed picture of the earth's structure available for petroleum exploration and production. It is the primary tool used by geophysicists to locate and map likely oil and gas plays, and is of increasing importance in advanced production techniques (enhanced oil recovery). Both imaging (the inference of structure) and inversion (the estimation of detailed predictive mechanical models) are active research areas. Some physical features of the subsurface are well-determined by seismic means, whereas others are not. In precision applications such as reservoir characterization and flood monitoring, it is as important to know what is not well-resolved as it is to have "an answer". Also unconstrained inversion results are likely to be geologically senseless. Since the mechanical parameters are nonlinearly related to the data, detailed understanding of resolution is difficult and rather recent. Geological "constraints" are likely to be qualitative in nature, therefore difficult to apply directly to pin down seismically unresolved features. In this minisymposium, the speakers will survey recent work in resolution, nonlinearity and constraints in the seismic context. They will address statistical (Bayesian) and deterministic sensitivity analysis of travel-time and waveform data, the influence of nonlinearity (velocity estimation and multiple reflections), and deterministic and statistical imposition of extra-seismic constraints.

(See MS17, Page 10 for Part 2)

Organizer: William W. Symes, Rice University

10:30 On the Determination of Slowness and Depth in Seismic Reflection Tomography
Kenneth P. Bube, University of Washington, and Robert T. Langan, Chevron Oil Field Research Company, La Habra, CA

11:00 Robustness and Regularization for Objective Functions
Stephen F. Elston, Mobil Exploration and Production Technical Center, Dallas

11:30 To Bayes or Not to Bayes: Statistical Inference for Large-Scale Seismic Inverse Calculations
John A. Scales, Colorado School of Mines

12:00 Steering Through the Null Space: The Specification of Constraint Matrices with Interactive Graphic Tools
Christof Stork, Advance Geophysical Corporation, Englewood, CO

MS13/Arboretum 2

High Resolution Ocean Modeling

The theme of the minisymposium is the necessity for performing systematic grid convergence studies (space and time) in ocean modeling. Such studies (or alternately, solution adaptive grid generation methods with reliable error estimates) are required in principle for any ODE or PDE study, as is generally acknowledged (certainly for nonlinear problems). In practice it is relatively rare, especially in geophysical simulations.

In this minisymposium, the speakers will demonstrate the methodologies for performing grid convergence studies and emphasize aspects of the geophysical results which would be qualitatively misleading if evaluated with inadequate grid convergence studies.

Organizers: Patrick L. Roache, Ecodynamics, Albuquerque, and David E. Dietrich, Institute for Naval Oceanography, Stennis Space Center Detachment, Mississippi

10:30 The Importance of Horizontal Resolution in Coupled Ice/Ocean Models of the Arctic
Steve Piacsek and R. Allard, Naval Research Laboratory, Stennis Space Center Detachment, Mississippi

11:00 Grid Convergence Studies for Coastal Ocean Models
Joannes J. Westerink, University of Notre Dame, and Rick Luettich, University of North Carolina, Chapel Hill

11:30 Coupling Flow and Transport Models for Highly Resolved Grids
Antonio Baptista, Oregon Graduate Institute of Science and Technology

12:00 A Numerical Study of Small-Scale Continental Shelf Features and their Interactions with Deep Water Flows
David E. Dietrich, Organizer

MS14/Arboretum 3

Simulation of Porous Media Flows and Contaminant Transport in Geological Waste Repositories (Part 1 of 2)

This minisymposium will address three critical issues in the modeling of waste repositories: 1) the use of adaptive logically rectangular grids; 2) the modeling of porous media flows in the resulting grids; and 3) the modeling of contaminant transport in the resulting flows. It is important to adapt grids to both special features of the repository such as wells and to adapt grids to the variability in the geologic structure of the repository. Using adaptive grids then complicates the modeling of the porous media flow; both finite-element and finite-difference methods can be used to handle resulting complexities. The contaminant transport can be approximated using finite-volume based algorithms based either on a generalized method of characteristics or on generalized high-resolution total-variation diminishing algorithms.

(See MS21, page 10 for Part 2)

Organizers: Thomas H. Robey, Spectra Research Institute/Sandia National Laboratories, Albuquerque and Stanley Steinberg, Ecodynamics Research Associates, Inc. and University of New Mexico, Albuquerque

10:30 Computational Issues in Modeling Ground Water Flow and Contaminant Transport
Thomas H. Robey, Stanley Steinberg, Organizers, et al. *(This talk will be developed by all of the participants in this minisymposium).*

11:00 Geostatistics and Upscaling of Hydrologic Properties for an Adaptive Mixed Finite Element Method Applied to Unsaturated Porous Media Flow
Thomas H. Robey, Organizer

11:30 Grid Adaption to Hydrodynamic Dispersion or Conductivity Tensors
Patrick Knupp, Ecodynamics Research Associates, Albuquerque

12:00 Sources of Numerical Instability in Transport Simulations in Dual Porous Media
Kambiz Salari, Ecodynamics Research Associates, Albuquerque

MS15/Arboretum 4

Homogenization for Flow and Transport through Porous Media

Homogenization is a method that allows rigorous derivation of averaged macro models on larger scales from micro models on small scales. This is important for media with microstructure and for heterogeneous media.

Darcy's law is well established for single phase flow in porous media; for multiphase flow a rigorous justification of the concept of relative permeabilities is missing. For fractured porous media special models are needed that describe the interplay between different regimes with small and large permeabilities.

In this minisymposium, the speakers will present various applications of the method of homogenization and demonstrate its usefulness.

Organizer: Ulrich Hornung, University of the Federal Armed Forces, Munich, Germany

10:30 Computational Justification of a Dual-Porosity Model for Two-Phase Flow in Fractured Media
Todd Arbogast, Rice University

11:00 Homogenization Methods for Modeling Transient Stokes Flows in Porous Media
Greg Allaire, Commissariat a l'Energie Atomique-DRN/DMT/SERMA, France

11:30 Models for Flow and Transport through Porous Media Derived by Homogenization
Ulrich Hornung, Organizer

12:00 Secondary Flux in Partially Fissured or Layered Media
Ralph Showalter, University of Texas, Austin

CP5/Arboretum 5

Finite Element Methods

Chair: James G. Uber, University of Cincinnati

10:30 Eulerian-Lagrangian Localized Adjoint Method for Contaminant Transport and Biodegradation
Richard E. Ewing and *Hong Wang,* Texas A&M University, College Station; and Michael A. Celia, Princeton University

10:50 Eulerian-Lagrangian Localized Adjoint Methods for Convection-Diffusion Problems in Multidimensions
Magne S. Espedal, University of Bergen, Norway; Richard E. Ewing and *Hong Wang,* Texas A&M University, College Station; and Helge K. Dahle, University of Bergen, Norway

11:10 Comparison of Hopscotch and Conjugate Gradient Techniques for Transient 3-D Porous Media Flow Problems
James G. Uber, University of Cincinnati

11:30 Velocity Computations for Streamline Computations
Tore Gimse, University of Oslo, Norway

11:50 A Block Sparse Direct Method for Fully Implicit Hydrocarbon Reservoir Simulation
A.S. Harouaka, KFUPM/RI, Saudi Arabia; and T. Ertekin, Pennsylvania State University, State College

12:10 Local Grid Refinement for Reservoir Simulation Applications
L. Chu, J.C. Diaz, M. Komara, and A.C. Reynolds, University of Tulsa

CP6/Ebony Room

Modeling II

Chair: Angela Pawell, Oregon State University

10:30 Effective Behavior of Two-Phase Flow in Highly Heterogeneous Porous Media
Alain P. Bourgeat and Abdelkader Hidani, University of St. Etienne, France

10:50 Transport of Reacting Solutes in Porous Media Affected by Chemical Equilibrium
Angela Pawell, Oregon State University; and Klaus-Dieter Krannich, Technical University, Cottbus, Germany

11:10 Analytical and Numerical Prediction of Unsteady Drawdown from a Finite Reservoir to an Infinite Reservoir
Lawrence J. De Chant, NASA Lewis Research Center

11:30 Analytical Solution of a General Potential Problem Developed for Applications to 2D-Reservoir Streamtube Models
Gotskalk S. Halvorsen, Institute for Energy Technology, Norway

11:50 Analysis of Jump Phenomena of Unsaturated Infiltrating Flow by Air Spring Model
Takao Nakayama and *Yuzo Yamane,* Ashikaga Institute of Technology, Japan

TUESDAY AFTERNOON, APRIL 20

12:30-2:00

Lunch

2:00/Regency Room

Chair: Richard A. Tapia, Rice University

Panel Discussion on Recognition and Rewards in Mathematics

Many demands are being made on our universities and colleges: Improve undergraduate education, contribute to the rescue of our K-12 school systems, help our industries become more competitive are only some of these demands. In response to these demands the Joint Policy Board for Mathematics (JPBM) established the Committee on Professional Recognition and Rewards chaired by Calvin Moore of the University of California. Its charge is to make recommendations concerning the rewards and recognition structure in Mathematics departments in universities and colleges that respond to these demands.

Richard Tapia, a member of the committee will describe the activities of the committee and present preliminary findings. An open discussion will follow.

Richard A. Tapia and **J.E. Dennis, Jr.**, Discussants Department of Mathematical Sciences, Rice University

2:45/Window Box

Coffee

3:15-5:15 PM

Concurrent Sessions

MS16/Regency Room

Efficient and Accurate Determination of Fluid Velocities

Effective transport of fluids in porous media depends strongly upon the accuracy of the techniques for determining the fluid velocity. The heterogeneity of the porous media, on many length scales, greatly complicates the velocity calculations since, in general, the velocity is determined through some version of d'Arcy's law. Mixed finite element, finite volume, and cell-centered finite difference methods will be discussed for the velocity and pressure approximation. These techniques can effectively treat the discontinuous and rapidly-varying permeabilities.

Due to the large size of field scale simulations, efficiency is also of critical importance. Effective preconditioners built from domain decomposition and multi-level techniques combined with multi-grid solvers will be discussed. These methods hold enormous potential for many applications from petroleum reservoir simulation, to the modeling of transport and remediation of contamination of groundwater.

Organizer: Richard E. Ewing
Texas A&M University, College Station

3:15 Preconditioning Techniques for Conforming Finite Element Methods
Joseph E. Pasciak, Brookhaven National Laboratory

3:45 Mixed Finite Element Methods and Block Finite Difference Methods for Accurate Computation of Fluid Velocities with Discontinuous Permeabilities
Richard E. Ewing, Organizer; Patrick O'Leary, University of Wyoming, Laramie; and *J. Shen,* Texas A&M University

4:15 A Mixed Finite Volume Element Method for Accurate Computation of Fluid Velocities on Irregular Quadrilateral
J. Jones, S. McCormick, and T. Russell, University of Colorado, Denver, and Z. Cai, University of Southern California

4:45 Application of Mixed Finite Elements to the Calculation of the Effective Permeability of Heterogeneous Porous Media
Louis J. Durlofsky, Chevron Oil Field Research Company, La Habra, CA

MS17/Arboretum 1

Seismic Imaging and Inversion: Resolution, Geological Constraints, and Algorithms (Part 2 of 2)

(For description, see MS12, Page 8)

Organizer: William W. Symes, Rice University

3:15 **Geological Constraints on Seismic Inversion**
Roelof Versteeg, Rice University

3:45 **An Inverse Scattering Method for Multiple Supression**
Arthur B. Weglein, ARCO Exploration and Production Co., Plano, TX

4:15 **Algorithms and Regularization for Traveltime Tomography**
Kenneth P. Bube, University of Washington, and Robert T. Langan, Chevron Oil field Research Co., La Habra, CA

4:45 **Objective Functions for Velocity Inversion**
William W. Symes, Organizer

MS18/Arboretum 2

The Impact of Ocean Waves on Coastal Regions

Coastal regions are exceedingly energetic zones in which wave energy from the ocean surface is concentrated, dissipated and reflected. When waves begin shoaling in coastal regions they experience significant nonlinear distortions and wave-wave interactions before ultimately breaking and running up on beach faces. Turbulence, air entrainment, and sediment entrainment occur in consequence of wave breaking. Currents are also generated that move sediment in the cross-shore and longshore directions so that the local bathymetry is significantly altered. In this minisymposium, the speakers will discuss mathematical aspects relating to such physical processes. In particular, attention will be paid to the three-dimensional evolution of waves up to and subsequent to breaking, and to currents and sediment transport in the surfzone.

Organizers: Joseph L. Hammack and William G. Pritchard, Penn State University, University Park

3:15 **Wave Design in Shallow Waters**
S.J. Buchan, Steedman Science and Engineering, Western Australia

3:45 **Wave Breaking and Surfzone Dynamics**
I. Svendsen, University of Delaware

4:15 **Mathematical Modeling of Nearshore Wave Propagation**
P. Liu, Cornell University

4:45 **The Kadomtsev-Petviashvili Equation and Water Waves**
Harvey Segur, University of Colorado, Boulder

MS19/Arboretum 3

Simulation of NAPL Groundwater Contamination

Many sites in the industrial world have been contaminated by non-aqueous phase liquids (NAPL). Gasoline storage tanks, petrochemical refineries, and fertilizer manufacturing are typical sources of these contaminants. Numerical modeling is an important tool for design of efficient remediation processes. This minisymposium will discuss various issues which arise in numerical simulation of multiphase subsurface NAPL flows. Modeling of spill scenarios, as well as remediation (thermal and isothermal vapour estraction) will also be discussed. The speakers will address both numerical issues and application of simulation models to real sites.

Remediation of NAPL contaminated sites is a topic of growing interest in the groundwater community. Many techniques for remediation (gas venting, steam injection, chemical flood) are being used experimentally, with very little stimulation being carried out. This minisymposium will bring together representatives from industry, academia, and government laboratories to discuss the difficulties in numerical simulation of these processes, and the practical benefits to be gained from modeling.

Organizer: Peter A. Forsyth
University of Waterloo, Canada

3:15 **Applying Simulation Models to Assess NAPL Behavior for Site Characterization and Remediation**
Everett P. Springer, Los Alamos National Laboratory

3:45 **A Unified Approach for Simulating NAPL Migration in the Subsurface**
Yu Shu Wu and Peter S. Huyakorn, S. Panday, and N-S. Park, HydroGeoLogic Inc., Herndon, VA

4:15 **Positive Coefficient Discretizations for Simulation of NAPL Remediation**
Peter A. Forsyth and Bei Yu Shao, University of Waterloo, Canada

4:45 **Modeling of NAPL Infiltration into Heterogeneous Soils**
Karsten Pruess, Lawrence Berkeley Laboratory

MS20/Arboretum 4

Hyperbolic Systems in Porous Media Flow

The theme of this minisymposium is the mathematical properties of hyperbolic systems of conservation laws arising in porous media flow. In particular, attention will be focused on the relation between properties of the systems and the performance of numerical methods. The speakers will discuss Riemann problems, Cauchy problems, questions of continuous dependence, stochastic systems and front tracking and other numerical techniques. They will describe some recent results on hyperbolic systems of conservation laws, and explain the consequences of these results for numerical computations.

Organizer: Ragnar Winther
University of Oslo, Norway

3:15 **Chromatography Theory of Gas Injection Processes for Enhanced Oil Recovery**
Franklin M. Orr, Stanford University

3:45 **Convergence of a Godunov Method for a Resonant System of Conservation Laws**
Eli Isaacson, University of Wyoming

4:15 **Fluid Flow in Stochastic Porous Media**
Helge Holden, University of Trondheim, Norway

4:45 **Front Tracking and Operator Splitting for Hyperbolic Conservation Laws**
Aslak Tveito, Center for Industrial Research, Norway

MS21/Ebony Room

Simulation of Porous Media Flows and Contaminant Transport in Geological Waste Repositories (Part 2 of 2)

(For description, see MS14, Page 8)

Organizers: Thomas H. Robey, Spectra Research Institute/Sandia National Laboratories, Albuquerque and Stanly Steinberg, Ecodynamics Research Associates, Inc. and University of New Mexico, Albuquerque

3:15 **Solution of Ground Water Flow Equations using Semi-coarsening Multigrid Methods**
Steve Schaffer, New Mexico Institute of Mining and Technology

3:45 **High Resolution Transport Calculations Using Multidimensional Upwind Methods**
Wendy A. Rice, Seattle, WA

4:15 **Assessing the Quality of Finite-difference Schemes for Porous-media Flows**
Bigyani Das, University of New Mexico

4:45 **Finite Difference Methods in Logically Rectangular Grids**
Stanly Steinberg, Organizer

3:15-5:15/Window Box

Poster Session 1

Numerical Simulation of Co-Metabolism of Chlorinated Solvents Coupled to a 3-Dimensional Flow and Transport Model
Bryan J. Travis and Nina D. Rosenberg, Los Alamos National Laboratory

An Inverse Problem Solution Method with Fractal and Discontinuity Constraints
Bryan J. Travis, Los Alamos National Laboratory and *Kim Edlund,* New Mexico Institute of Mining and Technology

On Spectrum of Large-Scale Vortexes in Ocean
Yuri K. Bratukhin and *Sergey O. Makarov,* Perm University, Russia

The Non-linear Behaviour of Large-scale Vortex Structures in the Helical Turbulent Fluid
Boris Leonid Smorodin, Perm University, Russia

Stability of Convection in Porous and Viscous Vertical Slots
Alexey Lipchin, Perm State University, Russia

Statistical Features of Hurricane Wind Fields
R.W.R. Darling, University of South Florida

Existence of a Solution to a Variational Data Assimilation Method in Two-dimensional Hydrodynamics
Carl R. Hagelberg, National Center for Atmospheric Research, and Oregon State University; and Andrew F. Bennett, Oregon State University

The Homogenized Spaces in the Theory of Rotating Stratified Flows
V.M. Kharik, Moscow State University, Russia; and University of Delaware

A Study of Ecosystem Formed by a Dam
Alfonso Castro, Escuela Politecnica Nacional, Ecuador

CP7/Arboretum 5

Transport in Porous Media

Chair: Richard Babarsky, James Madison University

3:15 **Riemann Solvers for Two-phase Flow at the Interface between Two Rock Types**
Jerome Jaffre, INRIA, Rocquencourt, France

3:35 **High Resolution Lattice Boltzmann Simulations of Fluid Flow in Porous Media**
Kenneth G. Eggert, ShiYi Chen, Darryl Grunau, Gary Doolen, and Bryan J. Travis, Los Alamos National Laboratory

3:55 **Time-Centered Advection Schemes for Convection Dominated Flows**
Robert Sharpley, University of South Carolina, Columbia; *Richard Babarsky* and James S. Sochacki, James Madison University

4:15 **Numerical Models for Unsaturated Flow in Deforming Porous Media**
Luis Resende and David Hibbitt, Hibbitt, Karlsson & Sorensen, Inc., Pawtucket, RI

4:35 **Effective Relative Permeabilities of Two-Phase Flow in Heterogeneous Porous Media**
Brahim Amaziane, Universite' de Pau, France

8:00/Regency Room

Business Meeting
SIAM Activity Group on Geosciences

WEDNESDAY MORNING, APRIL 21

7:30/Regency Foyer
Registration opens

8:30/Regency Room
IP6/Chair: Ronald F. Peierls, Brookhaven National Laboratory

Climate Stability and Nonlinear Dynamics

Warmer temperatures of recent years, and rising concentrations of greenhouse trace gases have produced heightened concern, in the scientific community and the public, about the possibility of a substantially warmer climate in the next century. In the 1970's, a few years of cooler temperatures and rising concentrations of anthropogenic aerosols generated a similar level of concern about the possibility of an impending ice age.

The climate system is an aggregate of subsystems — atmosphere, oceans, ice, biosphere and bedrock — with different characteristic time and space scales. The processes dominating climatic change are radiation balance, the hydrologic cycle, biogeochemical cycles and, on longer time scales, the slow flow of ice sheets and isostatic bedrock adjustment. This system, with its subsystems and processes, is subject to various external forcings - volcanic eruptions, solar variability, anthropogenic changes in atmospheric composition, orbital changes and tectonic plate motions, among others.

The speaker will present an overview of current knowledge on the stability of the Earth's climate. He will discuss simple equilibrium behavior, self-sustained, purely-periodic oscillations and forced, aperiodic oscillations. The time scale highlighted in this review will be that of Quarternary glaciation cycles - thousands to million of years. From this longer, more dispassionate perspective, the speaker will draw inferences about the interplay to be expected on the decades-to-centuries time scale between internal climate variability and anthropogenic trace-gas forcing. The key question is whether human forcing will succeed in destabilizing climate where larger forces have apparently failed.

Michael Ghil
Climate Dynamics Center, Department of Atmospheric Sciences, and Institute of Geophysics and Planetary Physics, University of California, Los Angeles

9:15/Regency Room
IP7/Chair: Ernest Chung, Chevron Oil Field Research Company

A Review of Current Trends in Petroleum Reservoir Simulation and Assessment of the Impacts on Oil Recovery

The speaker will present a general overview of current trends in petroleum reservoir simulation and the impacts associated with heterogeneous reservoir descriptions. He will discuss the nature of heterogeneities and the concept of scale sizes, the problems of averaging parameters and flow functions for the equations of motion in the context of core scale observations, and the significance of wettability and capillary pressure variations. He will describe methods for generating heterogeneities, review the techniques available for determining effective properties in both absolute and relative permeabilities, and summarize the problems of sensitivities of the anisotropic permeability tensor to the choice of boundary conditions. Finally he will describe an approach to simulating large reservoirs based on a synthesis of heterogeneous cross sections and streamtube methods.

F. John Fayers and T.A.Hewett
Department of Petroleum Engineering
Stanford University

10:00/Window Box
Coffee

10:30 AM-12:30 PM
Concurrent Sessions

MS22/Regency Room

Numerical Algorithms for Modeling Transport Phenomena in Porous Media (Part 1 of 2)

In this minisymposium the speakers will describe a collection of finite element/finite difference advection methods for transport dominated parabolic and hyperbolic systems. The mathematical models considered arise in petroleum reservoir engineering and groundwater hydrology. Computational issues will be emphasized, although theoretical results will also be provided by several speakers.

(See MS26, page 12 for Part 2)

Organizer: Mary F. Wheeler, Rice University

10:30 Second-Order Godunov Methods Black-Oil Reservoir Simulation
John B. Bell, Lawrence Livermore National Laboratory

11:00 Effective Property Calculations with Higher Order Methods
Michael Christie, British Petroleum, United Kingdom

11:30 A Triangle Based Mixed Finite Element - Finite Volume Technique for Modeling Two Phase Flow Through Porous Media
Louis J. Durlofsky, Chevron Oil Field Research Company, La Habra, CA

12:00 Front Tracking the Laminar to Slug Flow Transition
W. Brent Lindquist, State University of New York, Stony Brook

MS23/Arboretum 1

Reservoir Characterization

The detailed structure of an oil or gas reservoir can play an important role in the amount of hydrocarbon recovered. In determining the economic potential of a reservoir process, the variance in the expected recovery can be nearly as important as the most probable recovery. An accurate description of the rock properties can be critical in this regard. However, reservoir data are of limited availability and of varying accuracy and scale of resolution. Previous techniques have ignored much of the detail of the reservoir rocks, lumping the properties by various approximate or phenomenological techniques. In this minisymposium, the speakers address the issues involving the development of statistics appropriate for characterizing reservoir rocks and the use of those statistics to generate faithful realizations of rock properties.

Organizers: Richard T. Mifflin, Exxon Production Research Co., Houston, and Kamy Sepehrnoori, University of Texas, Austin

10:30 Analysis of Random Function Models in Terms of Spatial Entropy
Clayton V. Deutsch and *Marshall L. Grant*, Exxon Production Research Company, Houston

11:00 Application of Genetic Algorithm to Reservoir Description
M. Kelkar and X. Huang, University of Tulsa

11:30 Stochastic Modeling of Reservoir Facies
Naji Saad and Cindy T. Kalkomey, Mobil Research and Development Corporation, Dallas

12:00 Quantifying the Architecture of Heterogeneous Reservoirs
Noel Tyler, University of Texas, Austin

MS24/Arboretum 2

Some Aspects of Porous Media Research in the Netherlands

This minisymposium brings together a number of researchers, working in the Netherlands on a variety of disciplines related to flow in porous media. The first speaker is J. Bruining, who considers interface models for steam drive recovery of oil. In particular he will compare the outcome of the theory with experiments done at the Dietz Laboratory. The second speaker is S.M. Hassanizadeh, who will present a new theory describing two phase flow in porous media, taking into account interfacial areas. Then W.A. Mulder will speak on operator splitting techniques, carried out on a locally refined grid, and applied to, two phase flow including gravity. Finally, C.J. van Duijn will present the results of an analytic study concerning the decay of a pulse in the transport of reactive solutes through a porous medium.

Organizer: C.J. van Duijn
Delft University of Technology, the Netherlands

10:30 Interface Models for Steam Drive Recovery of Oil; Inclusion of Heat Losses
J. Bruining, Delft University of Technology, the Netherlands

11:00 Application of a New Theory of Two Phase Flow in Porous Media to Modeling the Unsaturated Zone
S.M. Hassanizadeh, National Institute of Public Health and Environmental Protection, Bilthoven, the Netherlands

11:30 On the Use of Operator Splitting for Two-phase Porous Media Flow with Gravity
W.A. Mulder, Shell Research - KSEPL, Rijswijk, the Netherlands

12:00 Asymptotic Profiles in Contaminant Transport
C.J. van Duijn, Organizer

MS25/Arboretum 3

Biodegradation, Dissolution and Other Forms of Reactive Flow and Transport

Environmental restoration of soils and groundwater to required national and state standards will continue to be a challenge for decades to come. In recent years, emphasis has shifted to the development and deployment of in-situ remediation techniques, whereby a physical, chemical or biological reaction is invoked to breakdown, dissolve or sometimes make insoluble contaminants disposed there by accident or intent. In this minisymposium, the speakers will explore techniques to simulate these complex processes, to successfully bring them to the field, and to understand how they work. They will address the mathematical and computational difficulties that must be accommodated, including sharp fronts, nonlinear phenomenon and widely disparate time scales.

Organizer: Kyle Roberson
Pacific Northwest Laboratory

10:30 3-D Bioremediation Simulations: Numerical Methods and Field Remediation Design Applications
Brian D. Wood, Pacific Northwest Laboratory, Richland, WA and A. Chilakapati, Rice University

11:00 A Simulation Approach Capable of Treating Either Equilibrium or Kinetically Controlled Reactive Transport in Groundwater
John C. Friedly, University of Rochester

11:30 Numerical Simulation of 3-Dimensional Hydrothermal Circulation with Precipitation Dissolution Effects
Bryan J. Travis, David R. Janecky, and Nina D. Rosenberg, Los Alamos National Laboratory

12:00 Incorporation of Observed Velocity Variations into Models of Contaminant Transport at the Moffett Field Groundwater Test Site
Margaret M. Lang, Lew Semprini, P. V. Roberts, and G. D. Hopkins, Stanford University

10:30 AM-12:30 PM/Window Box

Poster Session 1
(continued from Tuesday afternoon)

CP8/Arboretum 4

Atmospheric Modeling

Chair: Michael Ghil, University of California, Los Angeles

10:30 Optimal Control for Numerical Weather Prediction
Francois-Xavier Le Dimet, Universite Joseph Fourier, France

10:50 On the Numerical Difficulties and Remedies in the Finite Element Solution of Thermal Plumes with Strongly Temperature- Dependent Viscosity
David L. Coulliette, Air Force Institute of Technology and Manfred Koch, Florida State University

11:10 Contaminant Sedimentation Conditions Evaluation
Michael M. Medvedev, Russian Academy of Sciences, Russia; and Anatoly B. Zolotukhin, Russian Academy of Sciences, Russia and Rogaland University, Norway

11:30 Simulations of Low Cloud Layers with Emphasis on Particle Physics and Aerosol Distribution
Yefim L. Kogan, Douglas K. Lilly, Zina N. Kogan and Victor V. Filyushkin, University of Oklahoma, Norman

11:50 Absorbing Boundaries for Chebyshev Pseudo-Spectral Methods
Rosemary A. Renaut, Arizona State University and Jochen Frohlich, University of Kaiserslautern, Germany

12:10 Solution to the Charney Problem of Viscous Symmetric Circulation
Ming Fang and Ka Kit Tung, University of Washington, Seattle

CP9/Arboretum 5

Parallel Algorithms

Chair: E.F. D'Azevedo, Oak Ridge National Laboratory

10:30 Overview of HPCC Groundwater Activities at the Oak Ridge National Laboratory
E.F. D'Azevedo and C.H. Romine, Oak Ridge National Laboratory

10:50 Reservoir Simulations on KSR-1 Parallel Computers
Jianping Zhu, Mississippi State University

11:10 Parallel 3D Basin Modeling Code
Ruth Ann Manning and Paul D. Manhardt, Computational Mechanics Corporation, Knoxville; Lawrence M. Cathles, Cornell University; and A.J. Baker, University of Tennessee, Knoxville

11:30 Different Domain Decompositions at Different Times for Parabolic Problems
Daoqi Yang, Purdue University, West Lafayette

11:50 Application of Domain Decomposition in Solving Problems of Contaminant Transport in Fractured Rock
Tom Clemo and Leslie Smith, University of British Columbia, Canada

12:10 A Domain Decomposition Technique for Certain Free Boundary Problems
Caroline A. Papadopoulos and James M. Sloss, University of California, Santa Barbara

WEDNESDAY AFTERNOON, APRIL 21

12:30-2:00

Lunch

2:00/Regency Room

IP8/Chair: Mary F. Wheeler, Rice University

Macrodispersion for Flow in Porous Media

Macrodispersion is based on heterogeneity. Geological heterogeneities on all length scales give rise to the scale dependence of macrodispersion. This scale dependence, which leads to the inability to determine field scale macrodispersion from laboratory data, is known as the scale up problem.

To account for scale up parameter uncertainties in the porous media flow equations, dispersion parameters are set approximately from field scale studies at other locations, i.e. from engineering correlations. They are also set from fine scale simulations based on statistical simulations of heterogeneous geology. These methods suffer from insufficient data and the expense of obtaining new data.

The speaker will present a multilength scale theory for macrodispersion based on asymptotic analysis of the advection equation for a random velocity field, and compare this theory with results from the other methods (field data and simulations).

James G. Glimm
Department of Applied Mathematics and Statistics State University of New York, Stony Brook

2:45/Window Box

Coffee

3:15-5:15 PM

Concurrent Sessions

MS26/Regency Room

Numerical Algorithms for Modeling Transport Phenomena in Porous Media (Part 2 of 2)

(For description, see MS22, Page 11)

Organizer: Mary F. Wheeler
Rice University

3:15 Weak and Direct Eulerian-Lagrangian Localized Adjoint Methods for Nonlinear and Reactive Transport
Thomas F. Russell, Rick V. Trujillo, and David W. Dean, University of Colorado, Denver

3:45 A Characteristic-Mixed Method for Contaminant Transport and Miscible Displacement
Todd Arbogast, A. Chilakapati, and Mary F. Wheeler, Rice University

4:15 Study of Higher-Order Total Variation Diminishing Finite-Difference Schemes for Reservoir Simulation
Jianchun Liu, Gary A. Pope, and *Kamy Sepehrnoori,* University of Texas, Austin

4:45 Transport Methods for Highly Resolved Models of Heterogeneous Porous Media
David E. Dougherty, University of Vermont and Andrew F.B. Tompson, Lawrence Livermore National Laboratory

MS27/Arboretum 1

Transport in Media Which Possess Evolving Heterogeneity

Processes taking place over multiple scales of motion are the rule rather than the exception in natural porous formations. When there is no distinct separation of scales, nonlocal constitutive theories should be used to account for information propagation over the evolving heterogeneity. In this session, the speakers will present several nonlocal theories of transport, numerical experiments involving transport in fractal porous media, and a laboratory experiment aimed at verifying several transport theories for media with evolving heterogeneity.

Organizer: John H. Cushman
Purdue University, West Lafayette

3:15 Nonlocal Theories of Flow and Transport
Shiomo P. Neuman, University of Arizona

3:45 Numerical Experiments with Transport in Fractal Porous Media
Stephen W. Wheatcraft, University of Nevada, Reno

4:15 Nonlocal Theories of Dispersion in Porous Media
T. R. Ginn, Battelle Pacific Laboratory, Richland, WA

4:45 Fractal Analysis of Random Walks in Porous Media
Robert A. Greenkorn, Purdue University, West Lafayette

MS28/Arboretum 2

Reservoir Simulation Research at INTEVEP, S.A.

In this minisymposium, researchers in various parts of the field of geoscience working at INTEVEP, Research and Development and Technical Support Institute of Petroleos de Venezuela, will present an overview of the recent developments in the area and highlight advances in modeling, algorithms and applications.

Organizers: Saul Buitrago and Enrique Rodriguez
INTEVEP, S.A., Venezuela

3:15 Sequential and Parallel Ordering Techniques for Solving Linear Systems Arising in Reservoir Simulation
Saul Buitrago, Organizer

3:45 Modeling the Porous Media by Means of Conditional Boolean Simulation
Gustavo Gedler, INTEVEP, S.A., Venezuela

4:15 A Mathematical Model of Microbial Enhance Oil Recovery
Enrique Rodriguez, Organizer

4:45 Production Estimation on Well Subject to Cyclic Steam Injection
Douglas Rodriguez, INTEVEP, S.A., Venezuela

MS29/Arboretum 3

Wavelet-Based Methods in the Geosciences

Wavelets are a mathematical development with well publicized impact in the worlds of signal and data processing and numerical analysis. The purpose of this minisymposium is to explore the applications of wavelets in the geosciences. Particular emphasis will be placed on wavelet-based numerical methods for solving partial differential equations relevant to seismology and reservoir simulation. The speakers will address mathematical and computational issues and discuss recent developments and new avenues of research.

Organizers: Siamak Hassanzadeh and Sergio Zarantonello, Fujitsu America, Inc., San Jose, CA

3:15 **Wavelet-Based Algorithms for Linear Initial Value Problems**
Bjorn Engquist, University of California, Los Angeles

3:45 **Wavelet Transform Methods for Geophysical Applications**
Douglas J. Foster, ARCO Exploration and Production Technology, and Siamak Hassanzadeh, Organizer

4:15 **Wavelet Solution of Partial Differential Equations: Examples**
Roland Glowinski, University of Houston, University Park, and INRIA, France

4:45 **Wavelet Galerkin Discretization for Scattering**
Wayne Lawton, The Analytic Sciences Corporation, Cambridge, MA

CP10/Arboretum 4

Oceanography

Chair: Alan J. Wallcraft, Planning Systems, Inc., Slidell, LA

3:15 **On the Formation and Evolution of Sand Ridges**
Juan Mario Restrepo, Argonne National Laboratory; and Jerry L. Bona, Pennsylvania State University, University Park

3:35 **A Predictive Model of Ocean Surface Currents**
Robert O. Reid, Texas A&M University, College Station; and Hernan G. Arango, Harvard University

3:55 **Matching the Eulerian--Z Coordinate to the Density Coordinate for Ocean Modeling**
Ragu Murtugudde, Columbia University and Mark A. Cane, Lamont-Doherty Geological Observatory

4:15 **Leading Wave of a Turbulent Bore**
Harry Yeh, University of Washington, Seattle

4:35 **The Propagation of Short Gravity Waves over Long Waves and Bottom Topography in the Ocean**
Nessan Fitzmaurice, Case Western Reserve University

4:55 **An Empirical Study of Ocean Model Convergence**
Alan J. Wallcraft, Planning Systems, Inc., Slidell, LA; and Daniel R. Moore, Imperial College, United Kingdom

5:15 **Simulation of Fluvial and Nearshore Processes**
Young-Hoon Lee, Christoph Ramshorn and Johannes Wendebourg, Stanford University

CP11/Arboretum 5

Adaptive Methods

Chair: Richard D. Hornung, Duke University

3:15 **Development and Application of an Adaptive Collocation Technique to the Simulation of Two-phase, Cappilary Buckley- Leverett Flow**
Manfred Koch, Florida State University

3:35 **Adaptive Mesh Refinement for Polymer Flooding**
Richard D. Hornung, Duke University

3:55 **Moving Finite Element Modeling of 2-D Unsaturated Flow**
Christopher L. Cox and Walter F. Jones, Clemson University

4:15 **A Two Phase Front Tracking Reservoir Simulator with Phase Transitions**
Frode Bratvedt. Kyrre Bratvedt, Christian Buchholz, Tore Gimse, *Helge Holden,* Lars Holden, Rudi Olufsen and Nils Henrik Risebro, Technical Software Consultants, Norway

4:35 **The Riemann Problem for a System of Conservation Laws Modeling Three Phase Flow in Porous Media**
Tore Gimse and *Nils Henrik Risebro,* University of Oslo, Norway

4:55 **Front Tracking for Three Phase Flow in Porous Media**
Tore Gimse and Nils Henrik Risebro, University of Oslo, Norway; and Helge Holden, Norwegian Institute of Technology, Norway

CP12/Ebony Room

Parameter Identification II

Chair: Dan Marchesin, Instituto de Matematica Pura é Aplicada, Brazil

3:15 **Reservoir Characterization as an Inverse Problem**
Frederico Furtado, Dan Marchesin and Maria Amelia Novais, Instituto de Matematica Pura e Aplicada, Brazil

3:35 **Mollified Hyperbolic Method for the Identification of Diffusivity Coefficients**
Carlos E. Mejia and Diego A. Murio, University of Cincinnati

4:15 **Empirical Models for Estimating Dissolution and Biodegradation During Transport**
Robert S. Maier and W. J. Maier, University of Minnesota, Minneapolis

4:35 **Simulation of Heterogeneous Reservoirs using Projection onto Convex Sets**
Alberto Malinverno and David Rossi, Schlumberger-Doll Research

4:55 **Optimal Observation Scheduling for Groundwater Idenfication**
S.A. Belbas and *Min Sun,* University of Alabama, Tuscaloosa

5:15 **Exact Effective-Stress Rules for Transport in Porous Media**
James G. Berryman, Lawrence Livermore National Laboratory

5:35 **Application of Nonlinear Optimal Control to Groundwater Remediation Under Parameter Uncertainty**
Christine A. Shoemaker, Gregory Whiffen and Li-Zhi Liao, Cornell University

6:00

Conference Adjourns

The speaker is shown in italics for papers with multiple authors, if known at press time. Contributed presentations are spaced twenty minutes apart, allowing fifteen minutes for each presentation and five minutes for discussion. Minisymposium presentations are spaced thirty minutes apart, allowing twenty-five minutes for each presentation and five minutes for discussion.

Note
CP = Contributed Presentation
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Directly connected to the Hyatt is the Tunnel System. A six mile system of underground pedestrian tunnels downtown including a variety of shops and restaurants connecting all major buildings. The American Institute of Architects, Tranquility Park, Houston's downtown theatre and cultural district covering 16 blocks are all within walking distance of the Hyatt.

Parking

Regency Parking is located adjacent to the Hyatt. There is a walkway that connects the parking lot to the third floor of the hotel. A special discounted rate of $5.50 has been established for SIAM conference attendees. Valet parking is available at the hotel at a rate of $9.00 per day. Bring your parking ticket to the SIAM or Hyatt registration desk and mention that you are attending the conference and your parking ticket will be validated.

Babysitting Service

Babysitting service is available through the hotel's Concierge Desk by calling 713-654-1234. Babysitting is done in your room with the exception of Friday and Saturday evenings where the hotel features Camp Hyatt for children 3 - 15 years of age. The cost ranges between $5-$8 per hour for the first child and $1 per hour for each additional child. SIAM supplies the information, but in no way takes responsibility or is liable for any damages that may occur by using any of the suggested services. It is the responsibility of the attendees to choose the service that best suits their needs.

GET-TOGETHERS

SIAM Welcoming Reception
Sunday, April 18, 1993
6:30 PM - 8:30 PM
Window Box

Cash bar and assorted mini hors d'oeuvres.

Meet-and-Greet Hour
Monday, April 19
6:00 PM - 7:00 PM
Window Box

Come join your colleagues for some beer or sodas and some chips and dip while you talk about the day's events or make plans for dinner.

Cost $5

Business Meeting
SIAM Activity Group on Geosciences
Tuesday, April 20
8:00 PM
Regency Room

Anyone who is interested in the SIAM/AG on Geosciences or who would like to join is welcome.

REGISTRATION INFORMATION

Please complete the Preregistration Form found on the back of this program. We urge attendees to register in advance to get the lower registration fee. The preregistration deadline is Monday, April 5, 1993. The registration desk will be located in the Regency Foyer and will be open as listed below:

Saturday, April 17	6:00 PM - 8:00 PM
Sunday, April 18	7:30 AM - 4:00 PM 6:00 PM - 8:00 PM
Monday, April 19	7:30 AM - 4:00 PM
Tuesday, April 20	7:30 AM - 4:00 PM
Wednesday, April 21	7:30 AM - 2:00 PM

Registration Fees

	SIAM/AG* Geosciences	Member	Non Member	Student
TUTORIAL				
Preregistration		$120	$135	$55
Registration		$135	$155	$75
CONFERENCE				
Preregistration	$125	$130	$175	$25
Registration	$155	$160	$205	$25

* Members of SIAM Activity Group on Geosciences.

NOTICE

There will be no prorated fees. No refunds will be issued once the conference has started. If SIAM does not receive your Preregistration Form by Monday, April 5, 1993, you will be asked to register and pay the full registration fee for the conference.

CREDIT CARDS

SIAM accepts Visa, MasterCard and American Express for payment of registration fees, special functions, memberships, and book orders. When you complete the Preregistration Form, please be certain to indicate the type of credit card, the account number and the expiration date.

TELEPHONE MESSAGES

The telephone number of the Hyatt is (713) 654-1234. The Hyatt Hotel will either connect the caller with the SIAM registration desk or leave a message in the attendees hotel room.

NON-SIAM MEMBERS

Non-member registrants are encouraged to join SIAM in order to obtain the member rate for conference registration and enjoy all the other benefits of SIAM membership. Join SIAM by sending your completed membership form (see p. 15 & 16) along with your conference registration form. Be sure to include both membership dues and registration fees in your payment for a savings of $45.00.

SIAM CORPORATE MEMBERS

Non-member attendees who are employed by the following institutions are entitled to the SIAM member rate.

Amoco Production Company
AT&T Bell Laboratories
Bellcore
The Boeing Company
BP America
Cray Research, Inc.
E.I. du Pont de Nemours & Company
Eastman Kodak Company
Exxon Research and Engineering Company
General Motors Corporation
GTE Laboratories, Incorporated
Hollandse Signaalapparaten, B.V.
IBM Corporation
ICASE
IDA Center for Communications Research
IMSL, Inc.
Lockheed Corporation
MacNeal-Schwendler Corporation
Martin Marietta Energy Systems
Mathematical Sciences Research Institute
NEC Research Institute
Supercomputing Research Center, a Division of Institute for Defense Analyses
Texaco, Inc.
United Technologies Corporation

BOOK ORDERING INFORMATION

TO ORDER

Use your credit card (AMEX, MC, and VISA):
Call toll free in USA: 800-447-SIAM / Outside USA call: 215-382-9800
Fax: 215-386-7999 / E-mail: service@siam.org

Or send check or money order to:
SIAM, DEPT. BC1993, P.O. Box 7260, Philadelphia, PA 19101-7260

Shipping and Handling
USA: Add $2.75 for first book and $.50 for each additional book.
Canada: Add $4.50 for first book and $1.50 for each additional book.
Outside USA/Canada: Add $4.50 per book.

HOTEL RESERVATION FORM

SIAM Conference on
GEOSCIENCES
April 19-21, 1993
Hyatt Regency Houston
Houston, Texas

Specially discounted rooms are being held for our exclusive use until Monday, March 29, 1993. After that date, reservations will depend on availability. Your reservation is not confirmed until acknowledged in writing by the hotel or verified by phone. When making reservations by phone, be certain to identify yourself as an attendee at the SIAM Conference on Geosciences.
Hyatt Telephone: 713-654-1234.

PLEASE SEND ME A CONFIRMATION

PLEASE PRINT

Name _____

Phone _____

Address _____

City _____ State _____ Zip _____

Please reserve a ❑ $83/Single ❑ $89/Double

Arrival Date _____ Arrival Time _____ Departure Date _____

I am enclosing my deposit for the first night's room rate. I choose to pay by:
❑ American Express ❑ MasterCard ❑ VISA ❑ Personal Check

Credit Card Number ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ Exp. Date _____

Deposit $ _____ Signature _____

Detach this card and enclose it in an envelope with postage and mail to:
Reservations, Hyatt Regency Houston, 1200 Louisiana Street, Houston, Texas 77002

PREREGISTRATION FORM

SIAM Conference on
GEOSCIENCES
April 19-21, 1993
Hyatt Regency Houston
Houston, Texas

Preregistration form and payment must be received at the SIAM office by Monday, April 5, 1993 or you will be required to pay the full registration fee. **Please make checks payable to SIAM.**

Registration Fees: (Please circle your appropriate fee category)

	SIAM/AG* Geosciences	SIAM Member	Non Member	Student
TUTORIAL				
Preregistration		$120	$135	$55
Registration		$135	$155	$75
CONFERENCE				
Preregistration	$125	$130	$175	$25
Registration	$155	$160	$205	$25
Meet-and-Greet Hour	$5	$5	$5	$5
TOTAL	$_____	$_____	$_____	$_____

* Members of SIAM Activity Group on Geosciences.

PLEASE PRINT

Name _____

Organization _____

Department _____

Office Address _____

City _____ State _____ Zip _____

Phone No. _____ Fax. No. _____ E-mail Address _____

Home Address

City _____ State _____ Zip _____

Please update my SIAM records ❑ Yes ❑ No

All correspondence from SIAM should be sent to the above address ❑ Home ❑ Business

NAME BADGE
I prefer my name and affiliation to read as follows:
Name: ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Affiliation: ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

I wish to pay by ❑ American Express ❑ VISA ❑ MC ❑ Check

Credit Card No. ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ Expiration Date _____

Signature _____

Local address in Houston _____

Detach this form and enclose it with payment in the envelope provided (domestic mail only) and mail to SIAM Conference Department, 3600 University City Science Center, Philadelphia, PA 19104-2688. Telephone: 215-382-9800; E-mail: meetings@siam.org; FAX: 215-386-7999. Preregistration and payment must be received by Monday, April 5, 1993 or you will have to pay the full registration fee.

CPGS93