

APPLIED MATHEMATICS

ANNUAL RESEARCH REPORT

2001

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1 APPLIED MATHEMATICS AT UNSW, 2001

In 2001, the Department was pleased to announce the appointment of Andrew Bassom of the University of Exeter as a Visiting Professor. Dr Bassom is an international authority on non-linear stability.

The year saw the departure of Liqun Qi to a Professorship at the Hong Kong Polytechnic University, and of Defeng Sun to an Assistant Professorship at the National University of Singapore. The Department wishes them well in their new positions. Dr Alex Opie retired after many dedicated years to the Department. In July, John Roberts joined the Department, his interests in integrable and chaotic dynamical systems adding to the existing strengths in these areas.

It is with great sadness that we record the death of David Mustard on 28th June 2001, following a long illness. David started with the School of Mathematics in 1959 as a lecturer and retired in 1995. In his retirement, he continued to work on the Fractional Fourier Transform and related topics until shortly before his death. David will be remembered by all who knew him as a generous, gracious and courteous colleague with a great love of learning and life.

During 2001, Ian Sloan continued his work as Chair of the International Program Committee for ICIAM 2003, to be held in Sydney in 2003. He was also appointed President-Elect for the International Council on Industrial and Applied Mathematics. Ian will take up the presidency for a four year term. Michael Banner continued as Chair of the Scientific Committee for Ocean Research Working Group engaged in an investigation of the role of wave breaking in upper ocean dynamics. Jason Middleton remains a Board Member of Airborne Research Australia and is on the Antarctic Science Advisory Committee. Lance Leslie continued as Director of the Centre for Atmospheric Modelling and Prediction. He is the Chair of the World Meteorological Organisation's Committee on Comparison of Regional Model Experiments. He is also on the Australian Academy of Science Committee II on Meteorology and Oceanography. Lance is a member of the American Meteorological Awards Committee and remains an Editor of the Journal of Meteorology and Atmospheric Physics. Colin Rogers served on the Sectional Committee for Mathematical Sciences of the Australian Academy of Science. He continued in his honorary positions as Membre Associate at the Centre De Recherches Mathematiques, Universite de Montreal, Canada and as Adjunct Principal Research Scientist at the Center for Dynamical Systems and Non-linear Studies, Georgia Institute of Technology, USA. He remained on the Editorial Boards of the Journal of Mathematical Analysis and Applications, Studies in Applied Mathematics and the International Journal of Non-linear

Mechanics. Vaithilingham Jeyakumar served as a member of the Advisory Committee for the 7th International Conference on Generalized Convexity/Monotonicity to be held in Hanoi, Vietnam in 2002. Matthew England is a member of the Scientific Steering Committee for both the Australian Community Ocean Model and the Ocean Carbon Cycle Model Intercomparison Project. He continued as an Honorary Research Associate at CSIRO Atmospheric Research and as an Honorary Research Fellow of the Antarctic CRC. Matthew remains on the Editorial Boards of the Journal of Marine Systems and of the Journal of Ocean and Atmospheric Data Management. Bill McLean continued as an Associate Editor of the ANZIAM Journal.

A number of members of the Department travelled overseas to be involved in research collaborations or to attend international conferences. Ian Sloan presented invited lectures at the International Conference on Scientific and Engineering Computing in Beijing, China and at the Toyota Conference on Scientific and Engineering Computations for the 21st Century in Shizuoka, Japan. He was also an invited speaker at a meeting on Numerical Integration and Its Complexity, held in Oberwolfach, Germany. Michael Banner visited the Isaac Newton Institute, Cambridge, and was an invited speaker at a Wind-Over-Waves Symposium held at Churchill College. Colin Rogers presented an invited lecture at the Pacific Rim Conference on Mathematics held at Academia Sinica in Taiwan and a plenary address at the Wave Phenomena III Meeting held at the Pacific Institute for the Mathematical Science at the University of Alberta, Canada. He spent three months at the City University of Hong Kong where he presented a series of research seminars on the Geometry of Soliton Theory. Invited lectures were presented at other universities in Hong Kong as well as at the Chinese Normal University and Fudan University in Shanghai, China. In Europe, he gave an invited lecture at the International Conference on Waves and Stability in Continuous Media held in Porto Ercole, Italy. In Argentina he visited the University of Buenos Aires and there gave an invited colloquium. Matthew England travelled to the USA where he was an invited speaker at the American Geophysical Union 2001 Boston Conference. He was also an invited speaker at the European Geophysical Society XXVI General Assembly. Bruce Henry attended the 21st International Conference on Statistical Physics held in Cancun, Mexico. He also travelled to New York to collaborate with Dr. Susan Wearne at the Mount Sinai School of Medicine. Mahadevan Ganesh was on SSP (Special Studies Programme) for 6 months and during this time spent extended periods at California Institute of Technology and the University of Texas. John Murray visited the Los Alamos National Laboratory and also presented some of the recent work with his collaborators on HIV and its interaction with the immune system at the 8th Conference on Retroviruses and Opportunist Infections held in Chicago. Wolfgang Schief travelled to the UK, where he gave a colloquium and two series of lectures at the University of Bath. He also presented invited lectures at

Loughborough University and at the Isaac Newton Institute, University of Cambridge. John Roberts also gave an invited lecture at the Isaac Newton Institute, University of Cambridge, as well as in the Integrability section of the Australian Mathematical Society Conference held in Canberra.

There were numerous international visitors to the Department and a vigorous seminar and doctoral programme were maintained.

The research areas of the Department are currently grouped as follows:

- Computational Mathematics
- Geophysical Fluid Dynamics
- Nonlinear Phenomena
- Optimisation and Optimal Control

The research of the Department was recognised by substantial support from the Australian Research Council. Michael Banner received external support from the US Office of Naval Research while Bruce Henry was a consultant on a US National Institute of Health Grant.

In summary, the year 2001 saw a sustained high level of research activity within the Department of Applied Mathematics.

Colin Rogers
Head, Department of Applied Mathematics

2 STAFF

2.1 Academic and Professional Staff

Scientia Professor

Ian H Sloan, BA BSc *Melbourne*, MSc *Adelaide*, PhD *London*, FAIP, FAA

Professors

Michael L Banner, BE MEngSc *Sydney*, PhD *Johns Hopkins*

Lance M Leslie, BA/MA Prelim. *Melbourne*, BSc (Hons) MSc *Sydney*, PhD *Monash*

Jason H Middleton, BSc PhD *Monash*

Colin Rogers, BA *Oxford*, MEd *Toronto*, MSc PhD DSc *Nottingham*, FinstP, FAA

Visiting Professors

Mark J Ablowitz, BS *Rochester*, PhD *MIT*

AP Bassom, BA *Oxford*, PhD *Exeter*

Roger Grimshaw, BSc, MSc *Auckland*, PhD *Cambridge*, FAA

Grafton Hui, BSc *Peking*, PhD, DSc *Southampton*

Vidar Thomée, Fil Kand *Lund*, Fil Dr *Stockholm*, KVA (*Sweden*)

Gongbing Peng, MSC *Moskow National University*

P Winternitz, BSc, MSc *Leningrad*, PhD *Dubna*

Associate Professor

Vaithilingam Jeyakumar, BSc *Jaffna*, PhD *Melbourne*

Senior Lecturers

Peter J Blennerhassett, BE *Western Australia*, PhD *London*

Mahadevan Ganesh, MSc *Trichy*, PhD *Bombay*

Bruce Henry, BSc PhD *UNSW*, FAIP

William D McKee, BSc *Adelaide*, MSc *Flinders*, PhD *Cambridge*

William McLean, BSc *Queensland*, PhD *ANU*

John F Middleton, BSc PhD *Monash*

John M Murray, MSc *NSW*, PhD *Washington*

Alex H Opie, BSc DipEd *Melbourne*, PhD *Monash*, FAIP

John AG Roberts, BSc *ANU*, PhD *Melbourne*

Yaping Shao, BSc *Zhonghsan*, Dipl Met *University of Bonn*, PhD *Flinders*

Robert S Womersley, BSc *Adelaide*, MSc PhD *Dundee*

Lecturer

David C Guiney, BSc PhD *Adelaide*

Associate Lecturer

Eileen M Sheppard, BSc *London*

Senior Research Officers

Ekaterini E Kriezi, MSc PhD Ms Civil Eng *Auth Greece*

Russel P Morison, MSc *Monash*

Visiting Fellows

Clio Cresswell, BSc PhD *UNSW*

Abbey Perumpanani, MB,BS *St John's Medical College*, DPhil *Oxford University*

Hongxia Yin, BSc *Hebei University*, MSc *Beijing University of Aeronautics and Astronautics*, PhD *Chinese Academy of Science*

Bo Yu, BSc MSc PhD *Jilin University*

QE2 Research Fellows

Matthew England, BSc PhD *Sydney*

Wolfgang K Schief, Dipl Phys. *Ludwig Maximilians U*, PhD *Loughborough*

Visiting Research Fellow

Yuzhu You, PhD *Sydney*

Honorary Visiting Fellow

James Neptune Lyness, DPhil *Oxford University*

Honorary Associates

Yufei Yang, PhD *Hunan University*

Senior Research Assistant

Lixin Qi, MS Chinese Acad Meteo Sci , BSc *Zhongshan Univ*, PhD *UNSW*

Research Associates

Mark Baird, BE *Sydney*, MSc *Hawaii*, PhD *Warwick*

Thang Cao, BSc *Macquarie*, BSc *Melbourne*, MSc, PhD *UNSW*

Parviz Irannejad, BagE, MSC *University of Tehran*, PhD *UNSW*

Suxia Liu, BEng, MEng *Hohai University*, PhD *Inst. Geography, Chinese Academy of Sciences*

Peter Oke, BSc (Hons) *UNSW*

Liping Xia, MSc, PhD *University of Hong Kong*

Hou-Duo Qi, BSc *Peking*, PhD *Chinese Academy of Sciences*

Guanglu Zhou, PhD *Chinese Academy of Sciences*

Jian Li, BSc *Inner Mongolia*, PhD *Shanghai Univ. Sci. Tech.*

Professional Officer

Gregory H Nippard, BSc *Sydney*

2.2 Staff Changes

Liqun Qi moved to the Hong Kong Polytechnic University as Professor.

Defeng Sun moved to the National University of Singapore as an Assistant Professor.

Alex Opie retired.

2.3 Appointments and Promotions

John Roberts took up an appointment as a Senior Lecturer in July 2001

Mahadevan Ganesh assumed a Senior Lecturership in September 2001.

2.4 Committee Memberships, Awards and Invitations

Michael Banner was an invited participant, speaker and wrap-up session coordinator, Surface Water Waves Symposium (13-31 August, 2001 Newton Institute, University of Cambridge). He was an invited speaker, Wind-Over-Waves Symposium (Churchill College, U. Cambridge) Isaac Newton Institute for Mathematical Sciences (3-5 September, 2001). He continued as Chair of the Scientific Committee for Ocean Research (SCOR) Working Group on “The Role of Wave Breaking in Upper Ocean Dynamics”. This group of specialists from Australia, Britain, Canada, Japan, Russia and the USA is producing an authoritative review article on recent research developments in this area that should be influential in guiding future research effort. The final formal meeting of the group was held during the Air Sea Interface symposium in January 13, 1999. A review article is in preparation for publication in the open literature.

Matthew H England continued to serve on the Editorial Boards for the Journal of Marine Systems and the Journal of Ocean and Atmospheric Data Management. He is a member of the Scientific Steering Committees for the Australian Community Ocean Model (ACOM) and the Ocean Carbon Cycle Model Intercomparison Project (OCMIP), and was a contributing author for the IPCC Third Assessment Report on Climate Change published in 2001. He continued as an Honorary Research Associate at CSIRO Atmospheric Research and an Honorary Research Fellow of the Antarctic CRC. Matthew was an invited speaker at the European Geophysical Society XXVI General Assembly and at the American Geophysical Union 2001 Boston Conference.

Bruce Henry attended the 21st International Conference on Statistical Physics, Cancun, Mexico, July 2001, and the Australian Statistical Mechanics Meeting, Canberra, Australia in November 2001.

Vaithilingam Jeyakumar is a member of the Advisory Committee for the 7th International Conference on Generalized Convexity/Monotonicity, to be held in Hanoi, Vietnam, August 2002.

Lance Leslie is the Director of the Centre for Environmental Modelling and Prediction, a UNSW centre within the School of Mathematics that receives almost all of its funding from external grants. It functions at the Kensington campus. Professor Leslie has remained an editor of Meteorology and Atmospheric Physics and is on the American Meteorology Society Awards Committee. He is Chair of the World Meteorological Organization’s Committee on Comparison of Regional Model Experiments (COMPARE), and on the Australian Academy of Science Committee on Meteorology and Oceanography. He is a Reader for Australian Research Council Grants.

Jason Middleton continued as a member of the Antarctic Science Advisory Committee, which advises the Minister for the Environment on matters concerning the conduct and planning of science in Antarctica. He also continued as a Board member of Airborne

Research Australia, a Major National Research Facility which utilises aircraft for airborne scientific investigations concerning meteorology, air quality and remote sensing of the earth. He also participated as a reader for the Earth Sciences Panel of the Australian Research Council.

John Roberts was an invited speaker and participant at the EuroWorkshop “Discrete Systems and Integrability” at the Isaac Newton Institute, University of Cambridge in September. Also in September, he was an invited speaker in the Integrable Systems minisymposium at the Australian Mathematical Society Conference, Canberra.

Colin Rogers continued on the Editorial Boards of Journal of Mathematical Analysis and Applications, Studies in Applied Mathematics and the International Journal of Nonlinear Mechanics. He continues to hold honorary positions as Membre Associé at the Centre de Recherches Mathématiques, Université de Montréal, Canada and as Adjunct Principal Research Scientist at the Center for Dynamical Systems and Nonlinear Studies, Georgia Institute of Technology, USA. He was a member of the Scientific Committee for the International Symposium on Computational Mathematics and Applications to be held in China in 2002. He is also served on the Sectional Committee for Mathematical Sciences of the Australian Academy of Science.

Wolfgang Schief was invited to give a colloquium and two series of lectures at the University of Bath, UK as part of visits in January/February and June/July. He gave invited lectures at Loughborough University, UK in July and the Isaac Newton Institute, Cambridge, UK in September.

Ian Sloan continued in his role as Chair of the International Program Committee for ICIAM 2003, the major international congress of industrial and applied mathematics which is to be held in Sydney from July 7-11 2003. During the year he was appointed as President-Elect for the International Council on Industrial and Applied Mathematics; he will take up the Presidency for a four-year term in July 2003. He was an invited speaker at the International Conference on Scientific and Engineering Computing at Beijing in March, the Toyota Conference on Scientific and Engineering Computations for the 21st Century in Shizuoka, Japan in October, and an Oberwolfach meeting on Numerical Integration and its Complexity in November.

Rob Womersley is on the organizing committee, and is webmaster, for the Sydney Financial Mathematics Workshop. He gave an invited talk at the recent Advances in Computational Mathematics conference in Japan.

3 AREAS OF RESEARCH

The Department of Applied Mathematics is highly regarded internationally as a centre for research, both fundamental and applied. The main areas of research are listed below, together with members of the Department involved as well as current adjunct faculty.

Computational Mathematics

M Ganesh, W McLean, I H Sloan, R Womersley
Adjunct Faculty: V Thomée

Early in 2000 the former Numerical Analysis group decided to refocus, taking a broader view of its research and teaching role in the Department and the School. The new name, Computational Mathematics, is intended to reflect that broader view, which now embraces computational optimisation and high performance computing, as well as the more traditional areas, and which encourages strong interactions with applications and with other groups in the School. Some areas of present research concentration are: boundary integral equations; efficient methods for linear and non-linear parabolic equations; approximation and integration problems on the sphere; multiple integration in large numbers of variables; and direct and inverse scattering from three- dimensional objects.

Geophysical Fluid Dynamics

M Banner, P Blennerhassett, M England, D Guiney, L Leslie, W McKee, J F Middleton, J H Middleton

This group applies analytical and computational methods, as well as observation and data analysis, to problems of engineering, environmental fluid mechanics, physical oceanography and meteorology. Areas of concentration include convection, stability of shear flows, water waves, internal gravity waves, wave-mean flow interaction and wave-topographic interaction. In the area of physical oceanography and meteorology, the group seeks to observe and model the physical processes occurring in the oceans and atmospheres. Methodologies used range from sea-going experiments and data analysis to numerical and analytical modelling. Interests include wind-wave generation, understanding the circulation of the coastal ocean and atmosphere and studying the dynamics of regional seas from the tropics to Antarctica. A developing interest is in climate change and its effects on a regional scale.

Nonlinear Phenomena

P Blennerhassett, B Henry, J Roberts, C Rogers, W Schief

Adjunct Faculty: MJ Ablowitz, AP Bassom, R Grimshaw, WH Hui, P Winternitz

Nonlinear equations are not, in general, amenable to exact solution and yet they model important physical processes such as chaos, soliton propagation and turbulence. The advent of the computer allied to such analytic techniques as the inverse scattering transform has paved the way for many advances in these subjects. The main interests of this group lie in nonlinear stability, chaos, fractals, image compression, bifurcations, integrable maps, symmetries of dynamical systems, nonlinear wave phenomena, Bäcklund and Darboux transformations, Painlevé analysis and the geometry of soliton theory.

Optimization and Optimal Control

V Jeyakumar, J Murray, L Qi, H.-D. Qi, R Womersley, G. Zhou

This group has interests in nonsmooth optimization, nonlinear optimization, mathematical programming, stochastic optimization, combinatorial optimization, multi-objective optimization, global optimization and optimal control. Computational methods and applications are prominent features. Current research includes the development and analysis of numerical methods for minimax problems, variational inequalities, reformulation and smoothing methods, nonlinear programming and optimal control. Applications include mathematical finance, cancer treatment and HIV, approximation and integration over the sphere and data mining.

4 RESEARCH ACTIVITIES

During 2001, departmental members have worked on a wide range of research projects in applied mathematics, and have participated in collaborative research activities with several distinguished researchers. The main research activities for the year are given below.

Michael Banner A field study investigating a new perspective on breaking probability for deep water waves (Banner, Babanin and Young, 2000) appeared in the *Journal of Physical Oceanography*. It reports encouraging support for a threshold behaviour on the significant wave steepness for parameterising the probability of wave breaking of the dominant ocean waves. This approach found further support in another paper on the extension of this work to shallow water environments (Babanin, Young and Banner, 2001) that appeared in the *Journal of Geophysical Research*. Complementing these studies, papers were submitted on fundamental aspects of deep water wave breaking (Song and Banner, Banner and Song) and microscale breaking (Peirson and Banner). An extension of the threshold approach to breaking onset of shorter wind wave components was undertaken in a collaborative investigation with Johannes Gemmrich and David Farmer. This introduced considerable additional complexity in the analysis techniques due to directionality and riding waves. Nevertheless, the findings supported a threshold behaviour for the shorter scales and a paper was written and submitted to the *Journal of Physical Oceanography*.

This year also saw the publication of the second paper describing the Southern Ocean Waves Experiment (SOWEX) in the *Journal of Physical Oceanography*. This innovative international collaborative air-sea interaction experiment was staged over the Southern Ocean in June 1992, with Banner as the Chief Investigator and involving scientists from UNSW, the CSIRO Divisions of Oceanography and Atmospheric Research, NASA Goddard Space Flight Center and the University of Massachusetts. The project has provided fundamental data quantifying the sea state response to wind stress and wind speed variations. It has significantly extended our knowledge of the sea surface drag coefficient, particularly for gale force wind conditions. It has also contributed a definitive data set on the electromagnetic bias due to ocean waves needed for correcting the TOPEX-POSEIDON satellite altimeter sea surface topography measurements now used routinely to monitor the global ocean circulation.

Ongoing research projects during 2001 included

- the influence of breaking waves on the vertical structure of upper ocean currents for storm conditions at the Bass Strait oil platform; further measurement of the probability of occurrence of breaking waves

- a laboratory study of nonlinear wave group evolution tracking the behaviour of the maximum of the energy envelope
- observational and computational model studies of the wave number spectrum of ocean wind waves, featuring a new source term for the spectral dissipation due to wave breaking;
- an observational study of the source term balance in shallow water wave spectral evolution on Lake George, Canberra.

Australian Collaborators during 2001: I.R. Young (ADFA/U. Adelaide): Shallow Water Wind Wave Evolution - Source Terms. A. Babanin (ADFA): Deep and shallow water wave breaking dependences.

Overseas Research Collaborations during 2001: M.A. Donelan, Rosenstiel School of Marine and Atmospheric Sciences, University of Miami: Shallow water wind wave evolution - source terms.

W.K. Melville and F. Veron, Scripps Institute of Oceanography, La Jolla, California: Shallow water dissipation rates due to wave breaking.

D.M. Farmer and J.R. Gemmrich, Institute of Ocean Sciences, Sidney, British Columbia: Multi-scale measurements of ocean wave breaking probability.

Peter Blennerhassett continued research in the field of linear and nonlinear hydrodynamic stability, with the main emphasis being on the stability of time dependent flows. This work on the instability of unsteady flows was continued with Dr Bassom (Exeter University, U.K.) who visited for 6 weeks. Work on the stability of flat Stokes layers continued, with calculations examining the nature of a quasi-steady approximation to the governing equations.

Matthew England continued his research activities in large-scale physical oceanography, ocean modelling, and climate processes. Particular interests include the circulation and variability of the Southern Ocean and its role in climate, assessing ocean models using geochemical tracers, and estimating climate change, ocean CO₂ uptake, and future sealevel rise. Research continues in the ocean's thermohaline circulation, stability, and feedback to the atmosphere. In 2001, Matthew developed the first off-line simulation of tracer transport derived from a global eddy-resolving model. Matthew also contributed a chapter to the *Encyclopedia of Ocean Sciences* on the topic of chemical tracer applications in ocean models. Other studies include the simulation of thermally-driven flow in Jervis Bay, analyses of paleoclimate states in a coupled model, and a three-box model of the ocean's thermohaline circulation. International collaborations include an ocean model of CO₂ uptake (with Dr. H. Thomas), a study of model/observed flow in the

South Atlantic (with Dr. L. Stramma), and an investigation of tracer applications in ocean models (with Professor E. Maier-Reimer).

Mahadevan Ganesh continued his research on developing efficient algorithms and analysis for differential and surface integral equations. In particular, during 2001 the focus was on developing efficient algorithms for mathematical models in scattering theory and water waves and for problems posed on spheres and slender domains.

During the second half of 2001, he was on six month Special Studies Program (SSP) leave. Ganesh spent a major portion (about 5 months) of the SSP period at California Institute of Technology (CALTECH) and about a month at University of Texas (UT), Austin. At CALTECH, he collaborated with Professor T. Hou on developing a fast computational method for simulation of water waves in three-dimensions, and with Professor H. Mhaskar on construction of a new class of weighted polynomial approximations on the sphere. During his one month stay at Texas Institute of Computational Mathematics (TICAM), UT, Austin, Ganesh collaborated with Professor G. Rodin on developing computational schemes for mathematical models on slender domains (bodies with disparate lengths). This Led to a new project on construction of efficient solutions for model problems on spheroids. Ganesh made substantial progress in all these projects with collaborators.

During the first half of 2001, Ganesh collaborated with Professor I. Graham (University of Bath) and Professor I. Sloan on the implementation of a spectral method for the forward scattering theory problem and with Professor R. Grigorieff (Technical University of Berlin) on a full discrete method for nonlinear boundary value problems. He has five international journal publications in 2001.

Bruce Henry in collaboration with Dr Murray Batchelor, Australian National University, studied diffusion on discrete lattices with absorbing boundaries. They obtained, for the first time, exact algebraic solutions for absorption probabilities on the triangular lattice. This problem had been considered to be algebraically intractable for almost forty years. Bruce presented the solution to the ANZIAM 2002 Meeting held in Canberra.

In a collaboration with Dr Susan Wearne, Mount Sinai School of Medicine, New York, Bruce investigated pattern formation in reaction-diffusion equations with fractional order temporal derivatives. Some of the theoretical results of this work were presented by Bruce at the 21st International Conference on Statistical Physics held in Mexcio in 2001 and at the Australian Statistical Mechanics Meeting held in Canberra in 2001.

A visit by Bruce to Dr Wearne's laboratory in New York in mid year was beneficial to their research on characterizing the morphology of neurons. They introduced a new cumulative mass method for dimension estimates that can be applied to aggregates of different sized particles. They then applied this technique to measuring mass fractal dimensions of neurons extracted from macaque monkeys. In this application they demon-

strated the utility of the technique in distinguishing between different neuron types that are visually similar but functionally distinct. This work was presented by Dr Wearne to the International Fractals 2003 Conference held in Spain.

Vaithilingam Jeyakumar continued to pursue research in Variational Analysis, Optimization and their applications. His research during the year focussed on convex composite programming, non-smooth variational analysis, and mathematical problems of data classification and machine learning. A visit by Phan Tinh of Hue University, Vietnam, at the end of year 2000 for three months, led to continue the work on non-smooth analysis and optimization of not necessarily Lipschitz continuous functions. This work resulted in papers on variational conditions for convex composite non-Lipschitz programming and on ordered continuous nonsmooth functions.

His ongoing collaboration with Professor Dinh The Luc, University of Avignon, France, on approximate Jacobian based nonsmooth analysis and optimization remains very active. A month long visit by Professor Dinh The Luc, University of Avignon, France, in July saw the completion of the collaborative work on interior and open mapping theorems for nonsmooth continuous maps. In other work with Professor Luc, he produced sharp first and second order variational conditions for convex composite problems.

During the latter part of the year he explored set containment characterizations which have played a key role in generating knowledge-based support vector machine classifiers. These are powerful tools in data classification and mining. He has obtained various new dual characterizations of the containment of a closed convex set, defined by infinite convex constraints, in a reverse-convex set, and in another convex set, defined by convex constraints.

Lance Leslie has continued his work in a variety of atmospheric modelling areas from global scales down to microscales. These include mesoscale and urban meteorology, high performance computing, predictability, and numerical weather prediction. Other research areas include severe weather events, prediction of air quality, and soil erosion modeling. He was co-editor of the book "Environmental Modelling and Prediction" which appeared in late 2001 and has already gone into a second printing.

Professor Leslie as Director of CEMAP enjoyed a large number of distinguished visitors during the year. These included Professor J.L. Chan, City University of Hong Kong; Professor Gong-Bing Peng, Senior Member of the Chinese Academy of Sciences; Dr. Robert Abbey Jr, Senior Research Program Manager of the US Office of Naval Research; and Dr. John Le Marshall, head of the satellite section of the Bureau of Meteorology Research Centre, Melbourne. During the year Professor Leslie acted as an external PhD examiner at the University of Hong Kong and at Monash University. He also attended two national and three international meetings as an invited participant.

Finally, Professor Leslie received an ARC Large Grant and two US Office of Naval

Research Grants. Two of these were jointly awarded with Professor Michael Banner, also from the School.

Bill McKee continued his work on wave propagation across a shearing current. He supervised the project work of the Master of Science and Technology student Rebecca Quaggin in this area and is writing up a paper for publication. He has also begun to investigate how the numerical method devised to treat the general problem can be used to study waves trapped by a jet-type current. His Ph. D. student David Ghisolfi produced the amended version of his thesis early in 2001. The degree has now been awarded. David and Bill are working on two papers stemming from the thesis on oceanic fronts off the coast of Brazil. Bill also supervised the final stages of the writing up of Greg Buckley's Ph.D. thesis on internal waves.

Bill McLean completed a joint paper with Mark Ainsworth (Strathclyde) on the use of multilevel diagonal scaling to precondition the linear systems arising in boundary element discretisations of elliptic problems with Neumann boundary conditions. Other joint work was with Youngmok Jeon, a visitor from Ajou University in Korea, and dealt with a new boundary element method for the biharmonic equation. Bill also began writing a 3D boundary element code that is currently about 1500 lines, and continued as an associate editor of the *ANZIAM Journal*.

Jason Middleton continued his oceanographic research on the topic of headland eddies, participating in a series of experiments investigating wake flows around Bass Point, south of Sydney. Greg Nippard prepared and implemented these experiments which also provide data for the PhD work of Chris Aiken and data for the Postgraduate Diploma project of Alison Stegman. Chris submitted his PhD which was approved late in the year. In conjunction with Moninya Roughan, further work was undertaken analysing the East Australia Current data set, acquired in 1998 and 1999 from Research Vessel Franklin. This work essentially led to the completion of Moninya's PhD thesis which was submitted in December. He also contributed to postgraduate supervision by co-supervising Jocelyn Dela-Cruz from the School of Biological Sciences. Ann-Marie Wong continued her work on Antarctic ocean circulation and bottom water formation driven by sea-ice formation. David Ghisolfi's PhD on river outflows off the Brazilian coast was awarded in March. Peter Tate's PhD thesis on the rise and dilution of buoyant jets in the coastal ocean was completed in draft form during the year, and is expected to be approved next year.

John Middleton continued his research into the Shelf-slope Circulation in the Great Australian Bight. The broad goals of this project were to conduct a sequence of numerical studies to determine the dynamics of wind-forced downwelling slope currents and the conditions for the existence of undercurrents along with the importance of thermohaline forcing, topography and the nature of the circulation during both summer and winter.

In summary, these goals have been very well met with the nature of the circulation determined and new physics established. The study of wind-forced downwelling (Middleton and Cirano 1999) detailed the importance of thermal wind shear and alongshore sea level gradients in driving undercurrents and in the detachment of water into the interior. In a companion study of wind-forced upwelling, (Middleton 2000) the conclusions made in the foundation paper of Sugimoto and Kitamura (1984) were shown to be wrong. The circulation has been shown to be dominated by new physical effects within the surface mixed layer. An idealised study detailed the effect of Bass Strait on adjacent shelf currents (Middleton and Platov 2000).

High-resolution numerical models of the winter and summer “mean” circulation were determined and the results compared favourably with data from the region. A surprising and important result is the development of an extensive westward flowing current (the Flinders Current) along the shelf slope, that is shown to result from the equatorward Sverdrup transport within the southern ocean (Middleton and Cirano 2001). The dynamics of this current were shown to be similar to western boundary currents.

While the Flinders Current leads to deep upwelling near the slope during wintertime, the model results and data show winds to downwell isotherms to depths of up to 400m, and in agreement with observations, drive an eastward coastal current ($\approx 40\text{cm/s}$) from Albany to Tasmania (Cirano and Middleton 2002). The magnitude of this model current can be large (up to 40cm/s) where the shelf is narrow and is in good agreement with observations. Off the west Tasmanian shelf, this current is named the Zeehan Current and results show it to be driven by winds and cross-shelf (rather than along-shelf) density anomalies. Baroclinic instability is shown to be the cause of eddies found over the shelf slope and that the 250 km wavelength of these features is triggered by alongshore variations in coastal topography. In the summertime case, the mean coastal winds reverse, although the Flinders Current remains and is shown to converge with shelf currents leading to an eastward current over the shelf break and downwelling (both observed). Nearest the coast, upwelling is found and compared with classical wind-forced upwelling and that which arises from advection alone.

In addition, studies were also made of the tidal circulation (Platov and Middleton 2000a) and new algorithms determined to reduce numerical errors (Platov and Middleton (2001). In addition, a windows interface package (“SeaScape”) was developed for visualisation and analysis of the extensive model output (Platov and Middleton 2000b). The package can handle a larger variety of coordinate systems than any currently available.

John Murray’s research in biomathematics developed in several areas. Collaboration on HIV and its interaction with the immune system continued with researchers in Australia and overseas. Some of this work was presented at the 8th Conference on Retroviruses and Opportunistic Infections in Chicago. This was preceded by a visit to

the Los Alamos National Laboratory for joint work with Professor Alan Perelson.

Research on hepatitis B, homeostasis of the immune system, and epidemiology of HIV and hepatitis C in injecting drug users in Australia were other topics of research. Some of the immunology research was presented at the Australian Society for Immunology conference in Canberra.

Dr Andrew Coldman from the British Columbia Cancer Agency visited for a two week period and this allowed development of a model of cancer chemotherapy that took into account heterogeneity of response between patients and of the tumour within each patient.

John Roberts was delighted to join the Department and the Nonlinear Phenomena group in July 2001. John continued his research across a number of areas of dynamical systems, reflected in his publications for 2001. With Mr Apostolos Iatrou (La Trobe), he discovered a large class of planar integrable maps that include and generalise the well-known QRT maps. A by-product of this work is a Lax pair and explicit (Jacobian elliptic) integration of the dynamics for a large subset of QRT maps. With Professor Michael Baake (Greifswald), John investigated symmetries and time-reversal symmetries of toral automorphisms in dimension greater than two (generalizing their earlier two-dimensional results). This work applied many results from algebraic number theory. Another project connected with so-called algebraic dynamics was completed with Mr Jim Pettigrew (La Trobe) and Dr Franco Vivaldi (Queen Mary, London). This was a foundational study of regular motions over finite phase spaces that involved p-adic analogues of Siegel discs.

John's ongoing collaborations include: investigation of symmetries and reversing symmetries of planar polynomial automorphisms (with Professor Baake); developing notions of integrability and nonintegrability for maps over finite phase spaces (with Dr Vivaldi); and exploring duality in integrable maps (with Dr Reinout Quispel (La Trobe) and Professor Hans Capel (Amsterdam)).

Colin Rogers has continued his research on Bäcklund transformations of surfaces and the geometry of soliton theory with an emphasis on physical applications. During 2001, invited lectures were presented at the Pacific Rim Conference on Mathematics held at Academia Sinica in Taiwan. During an extended visit to City University of Hong Kong, a lecture series was presented on the geometry of soliton theory. Invited lectures during this period were presented at Hong Kong Polytechnic University, The Chinese University of Hong Kong, Hong Kong Baptist University, Hong Kong University of Science and Technology as well as at Chinese Normal University and Fudan University in Shanghai, China. Invited lectures overseas were also presented at the International Conference on Waves and Stability in Continuous Media held in Porto Ecole and at the University of Buenos Aires, Argentina. A plenary address was given at the Wave Phenomena III Meeting held at the Pacific Institute for the Mathematical Sciences, University of Alberta

Canada. Within Australia, lectures were presented in the Departments of Mathematics at the University of Melbourne and at Monash University.

Wolfgang Schief has continued his research on the project ‘The generation and application of Geroch-type transformations in soliton theory’ as part of his QEII Fellowship. The aim of the project is to bring together for the first time the analysis of symmetry transformations of Geroch type as known for the Ernst and Einstein-Maxwell equations of general relativity and infinitesimal Bäcklund transformations in the context of a very general integrable (soliton) system, the so-called Loewner-Konopelchenko-Rogers (LKR) system.

Dr Schief has also pursued his research on the amalgamation of soliton theory, classical differential geometry, difference geometry and continuum mechanics. In particular, he has worked on solitonic connections with hydrodynamics, magnetohydrodynamics and fibre-reinforced materials and fluids with Professor Rogers. Projects were initiated with Dr. A.D. King, University of Bath, UK and Prof. A.S. Fokas, University of Cambridge, UK. Projects were completed with Professor B.G. Konopelchenko, Università di Lecce, Italy.

Ian Sloan continued to work on more projects than he can easily remember: on the construction of (randomised) quadrature rules in hundreds of dimensions with Stephen Joe and Frances Kuo (Waikato); on the complexity of integration and approximation with Henryk Woźniakowski (Columbia and Warsaw) and Erich Novak (Jena); on problems of approximation on the sphere with Rob Womersley; on direct and inverse scattering with Ganesh, Womersley and Xiaojun Chen (Shimane University); and on a novel approach to parabolic problems with Visiting Professor Vidar Thomée and Dongwoo Sheen (Seoul).

Rob Womersley continued research on the development, analysis and application of methods for solving optimization problems arising in approximation theory, finance and engineering. One project is the work with Professor Ian Sloan on the choice of interpolation points on the sphere, how good such interpolation can be, and approximation and cubature over the sphere. Another project, with Alan Brace of National Australia Bank, is on stochastic implied volatility models. With Hongxia Yin he is also working on efficient methods and application of complementarity problems.

5 RECENT PUBLICATIONS

5.1 Journal Articles and Conference Papers since 1999

In the following list, papers are grouped by staff member. Thus, papers with more than a single author from the department appear more than once.

Publications

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- [15] H. Goosse, E. Deleersnijder, T. Fichefet and **M. H. England**, Sensitivity of a World Ocean model including sea-ice and CFC transport to the parameterisation of vertical mixing, *J. Geophys. Res.*, **104** (1999), 13681–13695.
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5.2 Books and Edited Proceedings since 1998

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Y. Shao, *Physics and Modelling of Wind Erosion*, Vol. 23. Kluwer Academic Publishers, 2000.

5.3 Applied Mathematics Reports 2001

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Chen X, Qi H, **Qi L** and Teo Kok-lay, Smooth convex approximation to the maximum eigenvalue function, Applied Mathematics Report AMR01/6.

Henry BI and Wearne SL, Existence of Turing instabilities in a two-species fractional reaction-diffusion system, Applied Mathematics Report AMR01/7.

Sloan IH and **Womersley RS**, Good approximation on the sphere, with application to geodesy and the scattering of sound, Applied Mathematics Report AMR01/8.

Jeyakumar V and Luc DT, Convex interior mapping theorems for continuous nonsmooth functions and optimization, Applied Mathematics Report AMR01/9.

Ganesh M, Grigorieff RD and Mustapha K, Discrete Petrov-Galerkin scheme for boundary value differential and integral problems: theory and applications, Applied Mathematics Report AMR01/10.

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Sloan IH, QMC integration - beating intractability by weighting the coordinate directions, Applied Mathematics Report AMR01/12.

Sloan IH, Kuo FY and Joe S, Constructing randomly shifted lattice rules in weighted sobolev spaces, Applied Mathematics Report AMR01/13.

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6 EXTERNAL RESEARCH SUPPORT FOR 2001

The Department maintains a strong commitment to high quality research, and consistently attracts significant funding from the Australian Research Council.

6.1 Australian Research Council Large Grants Scheme

M Banner and L Leslie	\$65,000
Incorporation of wave breaking into coupled Marine wind-ocean wave models for severe weather conditions	
M England	\$50,000
Midlatitude variability in the Southern ocean and its role in Australian climate	
L Qi	\$55,000
Generalized Newton methods for constrained approximation problems and sum of norms problems	
C Rogers and W Schief	\$68,348
Deformation of isothermic surfaces and K -nets in membrane theory and nonlinear elasticity. Application of solitonic methods	
IH Sloan	\$70,000
Multivariate integration and approximation	
IH Sloan, W McLean and M Ganesh	\$74,214
Numerical analysis of evolution problems in several variables	

6.2 Australian Research Council Small Grants Scheme

M Banner	\$10,000
Critical energy and momentum growth rates in shoaling water waves	
P Blennerhassett	\$5,000
Stability of unsteady flows	
M England	\$11,000
A Southern Ocean Model intercomparison project	
BI Henry, SL Wearne, MT Batchelor	\$18,549
Fractional calculus models for fractal pattern formation	

V Jeyakumr	\$15,000
Variational analysis and methods for nonsmooth constrained optimisation problems with continuous data	
L Leslie	\$12,000
Air quality analysis and prediction over the greater Sydney region using a new coupled atmospheric and chemical microphysical forecasting model	
JF Middleton	\$10,000
The variability of shelf-slope circulation within the Great Australian Bight	
JM Murray	\$15,000
Quantitative analysis of human immunodeficiency virus, hepatitis B, and cancer chemotherapy	
L Qi	\$18,648
Generalized Newton methods for constrained approximation problems and sum of norms problems	
L Qi and RS Womersley	\$13,000
Newton-type methods for semidefinite problems and constrained approximation	
C Rogers and W Schief	\$19,600
Discretisation and geometry of solitonic systems. Application of Bäcklund transformations and Lie group symmetries	
C Rogers and W Schief	\$15,300
Isothermic surfaces and K -nets in elastic membrane theory and engineering design	
IH Sloan	\$20,000
Multivariate integration and approximation	
RS Womersley	\$17,348
Iterative methods for inequality constrained optimisation	

6.3 External Collaborative Grants

- M Banner** \$19,000
Office of Naval Research (Impact of air-sea interaction research on larger-scale geophysical flows)
- M England** \$10,500
ARC QEII Fellowship Circulation and variability in the Southern Ocean and its influence on Australian climate
- B.I. Henry (CI), S.L. Wearne, M.T. Batchelor** \$10,000
Fractional calculus models for fractal pattern formation, UNSW Research Support Program
- S.L. Wearne (PI), B.I. Henry (Consultant)** \$US15,600
Biophysically-based modelling of the velocity storage neural integrator, US National Institute of Health Grant
- S.L. Wearne (CI), P.R. Hof (CI), B.I. Henry (Consultant)** \$US90,000
Mathematical analysis and modelling of dendritic branching and spine distribution as correlates of neural integration and age-related deficits in working memory, Howard Hughes Medical Institute Grant

7 VISITORS

- Dr Jose Henrique G M Alves, 1 March - 32 August, 2001 (M Banner)
- Dr Andrew Bassom, U of Exeter, 1 January 2001 - 31 December 2002 (P Blennerhassett)
- Dr Murray Batchelor, 26-27 April 2001 (B Henry)
- Mr J Chan, City University of Hong Kong, 29 January-8 February 2001 (L Leslie)
- A/Professor Xiaojun Chen, Shimane University, Japan, 5 August-7 September 2001 (R Womersley)
- Dr Clio Cresswell, 1 March 2001-28 February 2003 (B Henry)
- Dr Andrew Coldman, 30 July-12 August 2001 (J Murray)
- Deborah Drevardark, University of Toulon, France, 22 August, 2001 (M England)
- Dr Christopher Fairall, NOAA Environmental Technology Laboratory, Boulder, CO, USA, 2-10 July 2001 (L Leslie)
- Dr Florence Gandilhon, University of Toulon, France. 22 August, 2001 (M England)
- Dr Tony Hirst, CSIRO Atmospheric Research, Aspendale, Victoria (M England)
- Dr Zhenghai Huang, Hong Kong Polytechnic University, 1 June-30 November 2001 (L Qi)

Professor Youngmok Jeon, Department of Mathematics, Ajou University Korea, 23 August 2000-22 August 2001 (I Sloan)

Dr Stephen Joe, Waikato University NZ, 12 February-22 March 2001 (I Sloan)

Dr Stephen Joe, Waikato University NZ, 10 May-22 July 2001 (I Sloan)

Prof Jun Kawabe, Dept Applied Science, Shinshu U Japan, 4-13 August 2001 (S Okada)

Professor Boris Konopelchenko, Universita di Leccdee, Italia, 27 February-30 April 2001 (C Rogers)

Miss Frances Kuo, University of Waikato NZ, 24 August-9 September 2001 (I Sloan)

Dr Ole Leth, Program for Regional Physical Oceanography and Climate, Chile, 1 April-29 September, 2001 (M England)

Dr T Luc, 1 July-1 August 2001 (V Jeyakumar)

Dr John Francis Le Marshall, 1 April 2001-30 March 2003 (L Leslie)

Professor Erich Novak, University of Jena Germany, 29 July-25 August 2001 (I Sloan)

Dr Alexander Opie, 23 July 2001-23 July 2003 (B Henry)

Professor Gongbing Peng, 21 February 2001-20 February 2003 (L Leslie)

Dr Abbey Perumpanani, Boston Consulting Group, Sydney, 1 June 2001-1 June 2003 (M Ganesh)

Professor Elijah Polak, Dept of Electrical Engineering & Computer Sciences, University of California at Berkeley, 6-20 August 2001 (L Qi)

Dr Dingguo Pu, City University of Hong Kong, 1 January-30 June 2001 (R Womersley)

Dr. Joachim Ribbe, University of Southern Queensland, 26-28 July, 2001 (M England)

Dr David Stevens, University of East Anglia, Norwich, UK, 3-6 July 2001 (M England)

Dr Defeng Sun, National University Singapore, 23 June-15 July 2001 (R Womersley)

Professor Manil Suri, University of Maryland Baltimore County, 16 May 2001 (M Ganesh)

Professor Vidar Thomée, Chalmers University of Technology Sweden, 17 December 2001-1 February 2002 (I Sloan)

Dr Xiaojiao Tong, Hokkaido University Japan, 1 May - 30 November 2001 (L Qi)

Professor Zeke Wang, 15 August-5 November 2001 (L Qi)

Professor Pavel Winternitz, Université de Montréal, Canada, 2 January-1 March 2001 (C Rogers)

Professor Henryk Woźniakowski, Colombia University, 21 July-31 August 2001(I Sloan)

Dr Yoshu You, 1 April 2001-31 March 2002 (M England)

Dr Yufei Yang, 1 January-31 December 2001 (R Womersley)

Dr Hongxia Yin, 1 January-31 December 2001 (R Womersley)

Dr Bo Yu, 1 May-30 November 2001 (L Qi)

8 CONFERENCES AND SEMINARS

8.1 Applied Mathematics Seminars

Organizer: M Ganesh

11 January

Professor V. Thomée (Chalmers University of Technology)

Maximum-norm estimates for parabolic finite element equations

24 January

Professor D. Lubinsky (Witwatersrand University, Johannesburg)

Some pertinent problems generated by Pade Pitfalls

8 March

Professor Fausto Gozzi (University of Rome)

On constrained optimal control problems arising in Economic theory

16 May

Professor Manil Suri (University of Maryland)

The approximation of the spectra of non-compact operators arising in buckling analysis

22 June

Craig Arthur (Honours Seminar)

Delayed onset sea breeze - a case study

8 August

Professor John W Perram (The Maersk Mc-Kinney Moller Institute for Production Technology, The Univ. of Southern Denmark, Odense)

The thermodynamics of heat engines from a dynamical systems perspective

16 August

Mr Jakob Bjerkemo (UNSW)

Visualization of scattered sound in three dimensions

8.2 Special Seminars

20 August

Jonathan Michael Borwein, FRSC, Gordon M Shrum Professor of Science & Director Centre for Experimental and Constructive Mathematics, Simon Fraser University, Burnaby, BC

Aesthetics for the Working Mathematician

19 September

Dr Peter Blennerhassett, UNSW

RTS - the new DETYA rules governing postgraduate research

8.3 Applied -Statistics Seminar

8 March

Professor Fausto Gozzi (University of Rome)

On constrained optimal control problems arising in Economic theory

8.4 Computational Mathematics Seminars

Organizer: M Ganesh

18 January

Professor D Sheen (Seoul National University)

Numerical locking-free nonconforming finite element methods for planar elasticity problems

25 January

Dr W McLean (UNSW)

Multilevel preconditioning for boundary element methods

5 April

Dr Y Jeon (UNSW, A-Jou University, Korea)

The cell boundary element method for elliptic pdes-local error analysis

12 April

Dr E Khmaladze (UNSW)

Geometric Brownian motion and Brownian bridge on the real line: theory, applications and computation

26 April

Dr E Khmaladze (UNSW)

Empirical distributions and processes in deterministic computations

1 May

Dr Jian Li (UNSW)

Numerical approximation of unsteady natural convection from a vertical flat plate

10 May

Dr Rob Womersley (UNSW)

Extremal interpolatory spherical designs

17 May

Dr Stephen Joe (University of Waikato, NZ)

Construction of lattice rules achieving strong tractability when the number of points is non-prime

24 May

Dr Russell Standish (Director, UNSW High Performance Computing Support Unit)

Your computational facilities at ac3 and freeware scientific computation

31 May

Dr Russell Standish (Director, UNSW High Performance Computing Support Unit)

Parallel programming with open MP

7 June

Dr Russell Standish (Director, UNSW High Performance Computing Support Unit)

Ecolab and open dimensional dynamic systems

14 June

Dr Stephen Joe (University of Waikato, NZ)

An introduction to Sobol' and other low discrepancy sequences

21 June

Dr W McLean (UNSW)

Fortran compilers and libraries for Linux

2 August

Professor Ken Kortanek, (University of Iowa)

Using Semi-infinite programming in wavelet filter design

7 August

Professor Ken Kortanek, (University of Iowa)

Building and using dynamic interest rate models

8.5 Continuous Complexity Seminars

9 August

Professor Henryk Woźniakowski, Columbia University and University of Warsaw
Tractability of multivariate problems

15 August

Professor Erich Novak, University of Jena, Germany
The complexity of numerical integration with a quantum computer

23 August

Professor Ian Sloan (UNSW)
Numerical integration in hundreds of dimensions

8.6 Quantitative immunology seminar

21 September

Dr John Murray
HIV-1 latency and ongoing infection: estimates from HIV-1 RNA and DNA dynamics

19 October

Dr Phil Hodgkin, Centenary Institute of Cancer Medicine and Cell Biology
T cell proliferation: Using models to explore the balance between life and death

8.7 Optimization Seminars

Organizer: Rob Womersley

15 June

Professor Gongyun Zhao, National University of Singapore
A review of complexity and convergence of interior point methods

2 October

Professor Vladimir Boltianski, CIMAT, Mexico
Linear robust optimisation

8.8 Oceanography, Meteorology and Fluid Mechanics

Organizer: Matthew England

23 April

Jaclyn Brown, School of Mathematics, UNSW

Interactions of ENSO, the Indian Ocean Dipole, Monsoon, and the Tropospheric Biennial Oscillation

20 June

Peter Oke, School of Mathematics, UNSW

A Modelling study of the three-dimensional continental shelf circulation off Oregon

27 June

You Yuzhu, Visitor, School of Mathematics, UNSW

Formation and transformation of North Pacific Intermediate Water

27 June

Professor Jason Middleton, UNSW

Winds and runway usage at Sydney Airport

29 June

Ole Leth, Program for Studies in Regional Physical Oceanography and Climate

A numerical study of the summer circulation off central Chile

3 July

Chris Fairall, NOAA Environmental Technology Laboratory, Boulder, CO

Air-sea flux parameterization from 0 to 20 m/s wind speeds

6 July

David Stevens, School of Mathematics, University of East Anglia, UK

The Scotia Sea: changes and exchanges

10 July

Mark Baird, UNSW

Benthic biological ecosystems stuff

17 July

Chris Aiken, School of Mathematics, UNSW

Nonnormal dynamics in coastal currents

26 July

Joachim Ribbe, University of Southern Queensland

Climate change: What is happening in the ocean?

31 July

Mark Baird, School of Mathematics, UNSW

Implications for photosynthetic organisms of being attached or suspended

22 August

Florence Gandilhon, University of Toulon, France

Tidal currents in the Southern Great Barrier Reef

22 August

Deborah Drevardark, University of Toulon, France

Southern Ocean climate variability in a coupled model

9 GRADUATE PROGRAMME

The Department maintains an active programme of study at the graduate level, by both course work and research. The degrees that can be obtained by course work at the graduate level are the Master of Science and Technology in Mathematics (MScTech) and Graduate Diploma in Oceanography (GradDip). The Doctor of Philosophy (PhD) and Master of Science (MSc) degrees are research degrees, obtained by carrying out a research project under the supervision of a member of staff. A total of 25 students were enrolled during 2001 for studies leading to higher degrees.

9.1 PhD Programme

The PhD degree provides a training in research up to the level necessary for initiating and carrying out unsupervised original work. The normal requirement for admission is an honours degree with a good class of honours but transfer from MSc candidature is also possible for MSc candidates who are making exceptional progress. Part-time PhD candidature is encouraged but only for candidates who can spend at least 20 hours per week on their research and are able to maintain regular contact with the university. A total of 22 students were enrolled in PhD programmes during 2001.

Student	Research Topic	Supervisor
Chris Aiken	Oceanography	Jason Middleton
Jaci Brown	Climate modelling	Leslie/England
Gregory Buckley	Flow over topography	McKee
ZhanLai Gao	Optimal control	Murray
Eunjoo Jung	Pollution modelling	Shao
F Khoury	Computational fluid dynamics	Broutman/Womersley
An Li	Turbulent particle transport	Shao/Sanderson
Josef Dick	High deimensional integration	Sloan
Helen Thurn	Nonlinear Dynamics	Rogers
Pter Tate	Oceanography	Jason Middleton
Bill Lilley	Atmospheric pollution	Shao
Lixin Qi	Climate change	Leslie
Moninya Roughan	Coastal processes	Jason Middleton
JinBao Song	Wave breaking	Banner
Eric Schultz	Air-sea interaction	Sanderson
Elly Spark	Mesoscale meteorology	Leslie/Dunsmuir
Neil Stilgoe	Ocean modelling	Sanderson
Kwok Tan	Atmospheric modelling	Leslie
Zhou Wang	Acid soil phenomena	Shao

Anne-Marie Wong	Oceanography	Jason Middleton
Peng Xu	Land salination	Shao
Haixiong Zhuang	Pollution modelling	Shao

In 2001, 7 students were awarded a PhD in applied mathematics.

- Chris Aiken *Stochastic forcing of nonnormal coastal flows* (Jason Middleton)
- Zhanhai Gao *Modelling human immunodeficiency virus and Hepatitis C virus epidemics in Australia* (John Murray)
- Jinbao Song *Breaking of surface gravity waves* (Mike Banner)
- Xuan Jiang *Non-ergodicity in symmetry Hamiltonians and the reliability of numerical simulation* (Bruce Henry)
- Bruce Buckley *Real-time prediction of significant weather near the Tasman Sea: High resolution numerical weather prediction studies* (Lance Leslie)
- Peter Coutis *Currents, coasts and cays: a study of tidal upwelling and island wakes* (Jason Middleton)
- David Ghisolfi *Oceanic fronts off the southern Brazilian coast* (Bill McKee)

9.2 MSc Programme

The MSc degree provides a basic training in research. Each candidate is given an individual research topic, after consultation with members of staff, and carries out research on the topic under the personal supervision of a member of staff. An honours degree is normally required for admission as an MSc candidate, but applicants with good pass degree may be admitted to a qualifying programme, which usually consists of part or all of the honours year of the department. The MSc degree can be undertaken either full-time or part-time (or in some cases, externally). A total of 3 students enrolled in MSc programmes during 2001.

Student	Research Topic	Supervisor
Agus Santoso	Climate Variability	England
Kassim Mustapha	Boundary value differential equations	Ganesh
Hamish Ramsay	Meteorology	Leslie

In 2000 two students completed coursework masters degrees:

Susan Wearne completed the Mmath degree (supervised by Bruce Henry) and Haixiong Zhuang completed the MscTech degree (supervised by Yaping Shao)