CURRICULUM VITÆ

Ionel Michael Navon

University Address	Department of Scientific Computing 483 SCL Florida State University Tallahassee, FL 32306–4120 (850) 644–6560
Date of Birth	
Marital Status	Married and 2 daughters
Status	U.S. Citizen
Education	B.Sc., (Mathematics, Physics and Meteorology), Hebrew University of Jerusalem, 1967 M.Sc., (Meteorology), Hebrew University of Jerusalem, 1971 Ph.D. (Applied Mathematics), The University of the Witwatersrand, Johannesburg, South Africa, 1979
Professional Experience	Professor Department of Mathematics, Florida State University, Tallahassee, Florida, 32306, 1991 Director of Applied Mathematics Program Director Optimization and Optimal Control, Florida State University, Tallahassee, Florida, 32306, 1992 and Associate Professor Department of Mathematics, Florida State University, Tallahassee, Florida, 32306, 1987–1990 and Faculty Associate Supercomputer Computations Research Institute, Florida State University, Tallahassee, Florida, 32306, 1987–present Professor (courtesy appointment)

Updated October 24, 2009

Department of Meteorology, Florida State University, Tallahassee, Florida, 32306, 1987–present

Faculty Associate
Geophysical Fluid Dynamics Institute, Florida State University, Tallahassee, Florida, 32306, 1987–present

Research Associate
Supercomputer Computations Research Institute, Florida State University, Tallahassee, Florida, 32306, 1985–1987

Senior Specialist Researcher
National Research Institute for Mathematical Sciences (NRIMS); Council of Scientific and Industrial Research (CSIR), Pretoria, South Africa, 1985

Honorary Professor
NRIMS, CSIR, 1985

External consultant to NASA/GSFC
Laboratory for Atmospheres Global Modeling and Simulation Branch on the continuing project 'High-latitude filtering in a global grid-point model, using model normal modes' (since June, 1984).

Professor
Dynamic Meteorology, Pretoria University, South Africa, (Delivered 2 semester course on "Special Topics in Numerical Weather prediction" at B.Sc. Honors Level) January–October, 1985.

Chief Researcher
NRIMS, CSIR, 1984

Visiting Senior University Scientist Research Associate
NASA/Goddard Flight Center at the Laboratory for atmospheres, the Global Modeling and Simulation branch, 1983–1984

Senior Chief Research Officer
NRIMS, CSIR, 1981–1983

Chief Research Officer
NRIMS, CSIR, 1979–1980

Senior Research Officer
NRIMS, CSIR, 1976–1978

Head, Applied Mathematics Section
TAMAM Subsidiary of Israeli Aircraft Industry, 1975–1976

Senior Research Meteorologist
Department of Numerical Weather Forecasting, The Israeli Meteorological Service, 1974–1975

Ph.D. Research Assistant

Department of Geophysical and Planetary Sciences, Tel-Aviv University, 1970–1973

M.S. Research Assistant
Hebrew University of Jerusalem, 1967–1970

Professional Societies

American Meteorological Society – Elected AMS Fellow 1997

SIAM – Society for Industrial and Applied Mathematics – Member

Israel Association of Professional Engineers

IDEA – International Directory of Engineering Analysts

SAMS – South African Mathematical Society – Member

IMACS – International Association for Mathematics and Computers in Simulation – Member

AMS – American Mathematical Society – Member

ACM – Association for Computing Machinery – Member

AGU –American Geophysical Union – Member

American Meterological Society – Fellow

Grant Support

NSF, Division of Atmospheric Sciences.PI $446, 427. 1988–1991.

Air Force Office of Scientific Research, Mathematics and Atmospheric Sciences Divisions. CO/PI $255, 000. 1988–1991.

Air Force Office of Scientific Research, Mathematics and Atmospheric Sciences Divisions. CO/PI $500, 000. 1992–1994.

NSF U.S. -France International Program. PI $18, 250. 1991–1993.

NASA Headquarters and NASA/GSFC PI $240, 000. 1991–1993.

NASA Headquarters and NASA/GSFC PI $110, 000 1993–1994.

NSF Division of Atmospheric Sciences PI $365, 000. 1991–1994.

NSF Division of Atmospheric Sciences PI $330, 000. 1994–1997.

NASA Headquarters and NASA/GSFC PI $110, 000 1994–1995.

NASA Headquarters and NASA/GSFC PI $110, 000 1995–1996.

NASA Headquarters and NASA/GSFC PI $330, 000 1997–2000.

Air Force Office of Scientific Research, Mathematics and Atmospheric Sciences Divisions. CO/PI $389, 000. 1996–1999.

NSF, Division of Atmospheric Sciences, PI $320,000 1998-2001.

NSF, Division of Atmospheric Sciences, PI $440,000 2002-2005.

NASA Headquarters and NASA/GSFC co- PI $125, 000 2005–2008.

NSF, CMG, PI $396,000 2003-2006.

NSF -CISE/CCF Division 2006-2008.

LANGUAGE SKILLS

1) English –full command.
2) French–full command.
3) Rumanian–full command.
4) Hebrew–full command.
5) Reading knowledge of German and Italian.

HONORS

1990 Who's Who in the South and South-West

1991 Who's Who in the United-States

1992 - and onwards Who's Who in the United-States

1991 - Men of Achievement- Cambridge International Edition.

1997- Who's Who in Science and Engineering

1997- Elected Fellow of the American Meteorological Society

2000 - National Research Council Senior Fellowship Award.

LIST OF REFEREED PUBLICATIONS

1. I.M. Navon, "Inclusion of Lateral Viscosity and the Application of a Matsuno Scheme in A Two-level Model of the General Circulation of the Atmosphere," in: Numerical Studies of Planetary Circulation of the Atmosphere, eds. A. Huss, (Air Force Cambridge Research Laboratories, EOAR, *Refereed by Scientists of the Air Force Cambridge Research Laboratories*, 1971) 67–146

   This paper describes the inclusion of a new time differencing scheme as well as the inclusion of a viscosity term in a model simulating the general circulation of the Earth's atmosphere.

2. I.M. Navon and Z. Alperson, "Application of Fourth-Order Finite-Differences to a Baroclinic Model of the Atmosphere," *Arch. fur Meteorologie and Geophysik. Biokl. Ser. A*, **27**, (1978) 1–19

   A Fourth order accurate finite-difference approximation has been systematically implemented in an operational baroclinic 3-D model, thus reducing truncation and phase errors and increasing the predictability of the model (Refereed).

3. I.M. Navon, "Application of a New Partly Implicit Time-Differencing Scheme for Solving the Shallow-Water Equations," *Beitrage fur Physic der Atmosphere*, **51**, (1978) 281–305

   A new partly implicit time differencing scheme is applied to the nonlinear shallow-water hyperbolic equations on a limited area domain allowing time steps 2.5 times larger than allowed by the CFL stability criterion and a good conservation of integral invariants of the shallow-water equations.(Refereed).

4. I.M. Navon, "ADI Solution of the Inverse Balance Equation over a Non-Rectangular Domain," *Arch. fur Meteorologie Geophysik. Biokl., Ser. A*, **28**, (1979) 39–52

   The Wachpress alternating direction implicit iterative method is applied to a nonlinear elliptic equation over a trapezoidal domain using a new embedding approach. A comparison with the S.O.R. method shows that the ADI method has a better rate of convergence by a factor of three. (Refereed).

5. I.M. Navon, "Finite Element Simulation of the Shallow-Water Equations Model on a Limited-Area Domain," *Appl. Math. Modeling*, **3**, (1979) 337–348

   A new Galerkin finite-element model of the nonlinear shallow water equations on a limited domain is presented. An extrapolated Crank-Nicolson scheme is used to quasi-linearize the nonlinear advective terms. The accuracy of the new scheme is compared against highly accurate finite-difference models. (Refereed).

6. I.M. Navon, "Finite-element Solution of the Shallow-Water Equations on a Limited-Area Domain with Three Different Mass-Matrix Formulations," 77–86 (1979) Proceedings of the Fourth Conference on Numerical Weather Prediction, Silver Spring, MD. American Meteorological Society.*Reviewed by the American Meteorological Society Review Board*

   Three mass matrix schemes, the consistent mass (CM), the lumped mass(LM) and the generalized mixed mass (GMM) scheme were used in the integration of a new finite-element model of the shallow-water equations. The accuracy of the model using the GMM scheme was found to be the best amongst the three schemes tested.

7. I.M. Navon and U. Muller, "FESW – A Finite-Element FORTRAN IV Program for Solving the Shallow-Water Equations," *Advances in Engineering Software*, **1**, (1979) 77–86

   The code of the program FESW a new finite-element method for solving the shallow-water equations is documented and the various algorithms are explained in detail for the potential user's benefit. (Refereed).

8. I.M. Navon, "ADIF, a Fortran IV Program for Solving the Shallow-Water Equations," *Computers and Geosciences*, **5**, (1979) 19–39

   The computer program implementing a new linear alternating direction implicit method due to Fairweather and Navon for a limited area finite-difference integration of the shallow-water equations model is fully documented. The various new algorithms employed are detailed, while long term runs are provided.(Refereed).

9. I.M. Navon and H.A. Riphagen, "An Implicit Compact Fourth-Order Algorithm for Solving the Shallow-Water Equations in Conservation Law Form," *Monthly Weather Review*, **107**, (1979) 1107–1127

   A novel fourth order compact implicit finite-difference scheme is applied for the first time towards the solution of the nonlinear shallow-water equations in conservation -law form. The fourth order differencing is implemented in a spatially factored ADI form. A Kreiss stability analysis of the mixed initial boundary value problem is also carried out. (Refereed).

10. I.M. Navon, "A Fourth-Order Compact Implicit Scheme for Solving the Nonlinear Shallow-Water Equations in Conservation Law Form," in: Notes on Numerical Fluid Dynamics, **2**, eds. Hirschel, (Vieweg, *Reviewed by GAMM- Geselfschaft fur Algemeine Mathematik und Mechanik*, 1980) 211–220

    The compact fourth order implicit finite difference scheme with third order uncentered boundary conditions is shown to be equivalent to a finite-element method with a half-lumped mass matrix with regular linear elements.

11. G. Fairweather and I.M. Navon, "A Linear ADI Method for the Shallow-Water Equations," *J. Comp. Phys.*, **37**, (1980) 1–18

    A new ADI method is proposed for the approximate solution of the shallow-water equations, based on a perturbation of a linearized Crank-Nicolson type of discretization. Its efficiency is demonstrated by performing long-term integrations with a known test problem. (Refereed).

12. I.M. Navon, "Implementation of 'A Posteriori' Methods for Enforcing Conservation of Potential Enstrophy and Mass in Discretized Shallow-Water Equations Models," *Monthly Weather Review*, **109**, (1981) 946–958

    A first time application of a Sasaki variational approach to the problem of enforcing 'a posteriori' the conservation of the integral invariants of the shallow-water equations in long-term integrations is presented. This approach is then compared with the Bayliss-Isaacson method of enforcing conservation of quadratic integral invariants.(Refereed).

13. I.M. Navon and H.A. Riphagen, "The Impact of GARP Global Data Sets DST-5 and DST-6 on Predictability Degradation in the Southern Hemisphere," in: Numerical Experimentation Programme, **1**, eds. Jan Rutherford, *Reviewed by the World Meteorological Organization Review Board* 2.1–2.5

    The results of a NASA funded research on the impact of assimilating satellite data information on the decay of predictability of numerical weather prediction models applied to the Southern hemisphere is presented.

14. I.M. Navon, "'A Posteriori' Numerical Techniques for Enforcing Simultaneous Conservation of the Integral Invariants," in: Notes on Numerical Fluid Mechanics, **5**, eds. Henri Viviand, *Reviewed by GAMM- Geselfschaft fur Algemeine Mathematik und Mechanik*, (Vieweg, 1982) 230–241 (343 pages)

    Three different techniques for enforcing "a -posteriori" simultaneous conservation of integral invariants of the shallow-water equations are presented. These include the Bayliss-Isaacson method, a variational method and finally a constrained optimization viewing the integral invariants as nonlinear equality constraints.

15. I.M. Navon, "A High Accuracy Combined Finite-Element and Compact Fourth Order, Two-Stage Galerkin Method," *Computational Mechanics Centre Publication, Reviewed by the Computational Mechanics Center Scientific Staff* , (1981) 1–20

    A new two-stage Galerkin finite-element method designed to accurately treat the nonlinear advective terms in barotropic fluid dynamics models is presented. (Refereed).

16. I.M. Navon, "A Numerov-Galerkin Technique Applied to a Shallow-Water Equation Model with Exact Conservation of Integral Invariants," in: Finite-Element Flow Analysis, eds. Tadahiko Kawai, (North Holland, 1982) 57–67 (1096 pages)

    A new high accuracy two-stage Galerkin Numerov-Galerkin finite-element method is presented and applied to the shallow-water equations in a channel on the rotating earth. Constrained optimization is used to enforce conservation of integral invariants. (Refereed).

17. I.M. Navon and R. de Villiers, "Combined Penalty Multiplier Optimization Methods to Enforce Integral Invariants Conservation," *Monthly Weather Review*, **111**, (1983) 1228–1243

    An Augmented Lagrangian constrained nonlinear optimization approach is applied for the first time to enforce conservation of the quadratic integral invariants of the shallow-water equations. Issues of consistent scaling as well as new developments in non -linear constrained optimization are presented. (Refereed).

18. I.M. Navon, "A Numerov-Galerkin Technique Applied to a Finite-Element Shallow-Water Equations Model with Enforced Conservation of Integral Invariants and Selective Lumping," *Journal of Computational Physics*, **52**, (1983) 313–339

    A new two-stage Numerov-Galerkin method is presented and applied to achieve a highly accurate discretization of the nonlinear advective terms in the shallow-water equations in combination with an Augmented Lagrangian multiplier penalty method enforcing conservation of integral invariants. (Refereed).

19. I.M. Navon, "Applications of Augmented-Lagrangian Methods in Meteorology-Comparative Study of Different Conjugate-Gradient Routines for a Large-Scale Problem," *NASA-Research Review 1983 – Global Modeling and Simulation Branch, Reviewed by the Scientific Staff of NASA Goddard Space Flight Center Scientific Staff*, **TM 86053**, (1983) 150–156

    Several conjugate-gradient methods for large scale minimization were tested on real-life problems and their performance compared in terms of robustness and computational efficiency by increasing accuracy requirements. The conjugate-gradient methods performed the inner iteration in an Augmented Lagrangian constrained minimization application.

20. I.M. Navon, S. Bloom, and L. Takacs, "Computational Aspects of the Non-linear Normal Model Initialization of the GLAS 4th Order GCM," *NASA-Research Review 1983 – Global Modeling and Simulation Branch, Reviewed by the Scientific Staff of NASA Goddard Space Flight Center Scientific Staff*, **TM 86053**, (1983) 106–113

    A Machenhauer nonlinear normal mode initialization was performed for the Goddard Laboratory for Atmospheric Sciences model. Both a leap-frog and a Matsuno time-integration schemes were used. The maximal impact of the nonlinear normal mode initialization was found to occur after 6-10 hours of numerical integration of the model. A new method for identifying computational modes was devised..

21. I.M. Navon, "Conservation-Laws in Fluid Dynamics and the Enforcement of their Preservation in Numerical Discretizations," in: International Series on Numerical Mathematics, **66**, (Basel, Boston and Stuttgart, 1983) 286–341 (341 pages) ISBN-376-43-15-61-X. In book "Numerical Solution of Partial Differential Equations: Theory Tools and Case Studies, Birkhauser edition, September 1983; also in "Seminar on the Numerical Solution of Partial Differential Equations, " Pretoria, February 1983, 1–57. In NRIMS Technical Report TWISK 246

    In this lecture notes various aspects of continuous and discrete conservation laws are reviewed. In particular the issue of conservation laws for fluid dynamics derived from a system of equations as an integrability problem on a manifold is discussed along with the preservation of the conservation laws for discretized nonlinear partial differential equations of fluid dynamics, using finite-difference, finite-element and spectral methods..

22. L. Takacs, I.M. Navon, E. Kalnay, "High Latitude Filtering in a Global Grid-point Model Using Model Normal Modes," NASA Research Review 1984 – Global Modeling and Simulation Branch, *Reviewed by the Scientific Staff of NASA Goddard Space Flight Center Scientific Staff* 84–86 (1985)

    A Machenhauer nonlinear normal mode initialization (NLNMI) was carried out and implemented using the Goddard Laboratory for Atmospheres 4-th order model. A new algorithm speeding up the convergence of the Machenhauer NLNMI is presented.

23. F.H.M. Semazzi and I.M. Navon, "A Comparison of the Bounded Derivative and Normal Mode Initialization Methods Using Real Data," *NASA Research Review 1984 – Global Modeling and Simulation Branch, Reviewed by the Scientific Staff of NASA Goddard Space Flight Center Scientific Staff*, **TM 86229**, (1985) 84–86

    The bounded derivative method proposed by Kreiss(1980) is compared with the normal mode initialization method using the Goddard Laboratory for Atmospheres fourth order barotropic global model in as far as their ability to filter high frequency gravity-inertia waves is concerned..

24. I.M. Navon and R. de Villiers, "The Application of the Turkel-Zwas Explicit Large Time Step Scheme to a Hemispheric Barotropic Model with Constraint Restoration," *Monthly Weather Review*, **115, No. 5**, (1987) 1036–1051

    A new application of the Turkel-Zwas explicit large-time step scheme is presented which addresses the issue of fast and slow time scales in a global shallow-water equations model. A new constraint restoration method satisfying the requirements that integral constraints be restored with the least squares change in the field variables has been implemented and tested against other methods. (Refereed).

25. E. Kalnay, I.M. Navon, and L. Takacs, "High Latitude Filtering in a Global-grid Point Model Using Model Normal Modes," (1985) Proceedings of the 7th AMS Conference on Numerical Weather Prediction, Montreal, June 17–26, 1985, .*Reviewed by the American Meteorological Society Review Board*

    In this paper we apply the global shallow-water equations normal modes towards the problem of high latitude Fourier filtering designed to avoid excessively short time steps imposed in the vicinity of the poles by linear stability criteria due to fast moving inertia gravity waves. This new approach is then compared to three classical Fourier high latitude filtering techniques..

26. I.M. Navon, S. Bloom, and L. Takacs, "Computational modes and the Machenhauer NLNMI of the GLAS 4th Order Model," 115–120 (1985) Proceedings of the 7th AMS Conference on Numerical Weather Prediction, Montreal, 115–120, June 17–26, 1985, .*Reviewed by the American Meteorological Society Review Board*

    A new method for identifying computational normal modes was put forward. The role of computational normal modes in the Machenhauer, Kitade and Rasch methods of nonlinear normal mode initialization is finally discussed.

27. F.H.M. Semazzi and I.M. Navon, "A Comparison of the Bounded Derivative and Normal Mode Initialization Methods Using Real Data," 108–114 (1985) Proceedings of the 7th AMS Conference on Numerical Weather Prediction, Montreal, 108–114, June 17–20, 1985, *Reviewed by the American Meteorological Society Review Board*

    The bounded derivative method is compared with the normal mode initialization method on a real data case. Results show that both methods are efficient in eliminating spurious gravity wave noise.

28. I.M. Navon, "A Review of Variational and Optimization Methods in Meteorology," (1985) Proceedings of the International Symposium on Variational Methods in Geosciences, Y.K. Sasaki, editor, held at the University of Oklahoma, Norman, OK, 1–5, October 15–17, 1985, *Reviewed by the International Scientific Committee on Variational Methods in the Geosciences*

    State of the art variational and optimization methods as applied in various fields of meteorology were reviewed.

29. I.M. Navon and R. de Villiers, "GUSTAF: A Quasi-Newton Nonlinear ADI FORTRAN IV Program for Solving the Shallow-Water Equations with Augmented Lagrangians," *Computers and Geosciences*, **12**, (1986) 151–173

    A nonlinear alternating direction implicit (ADI) method of Gustafsson (1971) is implemented and tested for a limited area finite-difference integration of the nonlinear shallow-water equations. The various algorithms used in the computer program are fully detailed, while an Augmented Lagrangian method is applied to enforce conservation of integral invariants. A nonlinear Quasi-Newton iteration is performed at each time step.

30. I.M. Navon and H. Riphagen, "SHALL4, A FORTRAN IV Compact Fourth-Order Implicit Program for Solving the Shallow-Water Equations in Conservation Law-Form," *Computers and Geosciences*, **12**, (1986) 129–150

    A computer code implementing a novel compact fourth order implicit finite difference scheme in a spatially factored form for solving the nonlinear shallow-water equations on a limited area domain is fully documented. Issues concerning control of aliasing as well as well-posedness of the numerical boundary condition are amply discussed(Refereed).

31. I.M. Navon, "A Review of Variational and Optimization Methods in Meteorology," (1986) in Festive Volume of the International Symposium on Variational Methods in Geosciences (Y.K. Sasaki, Ed.), Elsevier Science Pub. Co. Developments in Geo-mathematics, Vol. 5, 29–34, 1986, 300 pages

    State of the art variational and optimization methods as applied in various fields of meteorology were reviewed. In particular issues of application of large-scale direct unconstrained minimization and optimal control methods are discussed for the first time in the context of their application to meteorology.

32. I.M. Navon and F.H.M. Semazzi, "A Comparison of the Bounded-Derivative and the Normal Mode Initialization Methods Using Real Data," *Monthly Weather Review*, **114**, (1986) 2106–2121

    The bounded derivative method and the normal mode method are applied to global nonlinear barotropic model using real data. Results show that both methods lead to identical constraints up to a certain degree of approximation. Both methods are successful in eliminating gravity oscillations in the unbalanced height field. (Refereed) .

33. I.M. Navon, "FEUDX: A Two-stage High Accuracy Finite Element FORTRAN Program for Solving the Shallow Water Equations," *Computers and Geosciences*, **13**, (1987) 255–285

    The program implementing a new two-stage finite-element Numerov-Galerkin method for integrating the nonlinear shallow-water equations on a limited area domain is fully documented. Almost perfect conservation of the integral invariants is obtained by using an Augmented -Lagrangian method. Long term integrations have been performed using this code which has been adopted as a standard code in a number of European countries. (Refereed).

34. I.M. Navon, "PENT: A Periodic Cyclic Pentadiagonal System Solver," *Communications in Numerical Methods*, **3**, (1987) 63–69

    A new algorithm for solving cyclic pentadiagonal systems is presented and tested with a high order generalized spline for the calculation of the first derivative. (Refereed).

35. I.M. Navon and D.M. Legler, "Conjugate-Gradient Methods for Large-Scale Minimization in Meteorology," *Monthly Weather Review*, **115**, (1987) 1479–1502

    In an extensive review study available conjugate gradient algorithms are presented with the aim of assessing their use in large scale minimization problems in meteorology. An extensive theoretical background is also presented. The chosen methods are compared by applying them to two large-scale meteorological problems of interest using criteria of computational economy and accuracy. (Referred).

36. I.M. Navon and R. de Villiers, "The Application of the Turkel-Zwas Explicit Large Time Step Scheme to a Hemispheric Barotropic Model with Constraint Restoration," *Monthly Weather Review*, **115**, (1987) 1036–1051

    The Turkel-Zwas scheme is applied for solving the shallow-water equations on a fine mesh hemispheric domain using realistic initial conditions and a time step three times larger than allowed by explicit stability criteria. The terms associated with the fast gravity waves are treated on a coarser grid but to a higher accuracy than those associated with the slow propagating Rossby waves. (Refereed).

37. I.M. Navon, "FEUDX – A High Accuracy Finite Element FORTRAN Program for Solving the Shallow-Water Equations," in: Envirosoft '86, eds. P. Zannetti, (Computational Mechanics Publications, Boston and Los Angeles, *Reviewed by the Computational Mechanics Center Scientific Staff* , 1986) 484–502 (809 pages)

    Various computational issues related to the various algorithms in the two-stage Numerov-Galerkin finite-element model of the nonlinear shallow-water equations are addressed. In particular attention is focused on the use of selective lumping and the iterative solution of the resulting systems of linear algebraic equations. Postprocessing of the time evolution of the height field is finally discussed.

38. I.M. Navon, "The Bayliss-Isaacson Algorithm and the Constraint Restoration Method are Equivalent," *Meteorology and Atmospheric Physics*, **13**, (1987) 143–152

    The Bayliss and Isaacson (1975) method of modifying any given difference scheme so as to ensure conservation of the appropriate physical integral invariants is shown to be equivalent to the constraint restoration method of Miele(1969) subject to the requirement of least-square change in the state vector coordinates. Both methods are tested on a global shallow-water equations model.(Refereed).

39. M.K. Ramamurthy and I.M. Navon, "Application of a Conjugate-Gradient Method to Variational Blending Of Meteorological Fields," reviewed Proceedings of the Eight Conference On Numerical Weather Prediction, February 22–26, 1988, Baltimore, Maryland, 202–208 (860 pages), American Meteorological Society, *Reviewed by the American Meteorological Society Review Board*

    A new technique of direct minimization is used here to variationally blend meteorological fields obtained from a high resolution scheme over a limited area domain with a global field analysis from the European Centre for Medium Range Forecasts, subject to minimizing a cost functional. The aim is to retain large-scale information from the global field and blend it with detailed small-scale information from the limited area field..

40. B. Neta and I.M. Navon, "The Transfer Function Analysis of the Turkel-Zwas Scheme for the Shallow-Water Equations," *Journal of Computational Physics*, **81(2)**, (1989) 277–300

    A transfer function analysis is used to analyze the Turkel-Zwas scheme applied to the shallow-water equations. The novel transfer function approach allows us insight into the behavior of the discretization scheme in terms of a comparison between continuous and discrete amplitude, phase and group velocity coefficients. (Refereed).

41. D.M. Legler, I.M. Navon and J.J. O'Brien, "Objective Analysis of Pseudo-Stress Over the Indian Ocean Using a Direct Minimization Approach ," *Monthly Weather Review*, **117**, (1989) 709–720

    A variational approach is used to develop a novel objective analysis technique for pseudostress winds over the Indian Ocean. A cost functional is constructed, each of its terms measuring lack of fit to prescribed conditions. The cost functional is minimized using a conjugate gradient method for large-scale optimization. (Refereed).

42. I.M. Navon, "A Review of Finite-Element Methods For Solving the Shallow-Water Equations," in: Computer Modelling in Ocean Engineering, eds. B.A. Schrefler and O.C. Zienkiewicz, (A.A. Balkema Publishers, Rotterdam and Brookfield, *Reviewed by Profs B.A. Schrefler and O.C. Zienkiewicz*, 1988) 273–279 (727 pages)

    Shallow-water equations models have been used for a wide variety of coastal phenomena such as tide currents, pollutant dispersion, storm surges, tsunami wave propagation, etc. In this invited survey the application of finite-element methods for solving the shallow water equations is reviewed addressing mathematical issues such as variable resolution, computational efficiency and conservation of integral invariants.

43. I.M. Navon, P.K.H. Phua and M. Ramamurthy, "Vectorization of Conjugate-Gradient Methods for Large-Scale Minimization," in: Proceeding Supercomputing '88, (IEEE Computer Society and ACM SIGARCH, Washington, DC, *Reviewed by the IEEE Computer Society Scientific Review Board*, 1988) 410–419 (458 pages)

    A first time novel approach to the vectorization of the nonlinear conjugate-gradient method applied to large-scale unconstrained minimization is put forward. The vectorization results in speed-ups up to a factor of 21, compared to the performance of scalar code. Computational results are finally presented for minimization problems arising in meteorology..

44. D.H. Robertson, B.F. Brown, and I.M. Navon, "Determination of the Structure of Mixed Argon-Xenon Clusters Using a Finite-Temperature, Lattice Based Monte-Carlo Method," *Journal of Chemical Physics*, **90(6)**, (1989) 3221-3229

    Energy optimized structures of mixed Argon-Xenon are determined using a simulated annealing global minimization approach speeded up by a highly efficient memoryless quasi-Newton like conjugate-gradient unconstrained local minimization algorithm. The new approach has been found to be more efficient than the usual simulated annealing method. (Refereed).

45. I.M. Navon and B. Neta, "Application of Optimal Control Methods in Meteorology-4-D Data Assimilation Problems," in: ICIAM–87: Proceedings of the First International Conference on Industrial and Applied Mathematics, eds. James McKenna and Roger Temam, (SIAM, Philadelphia , 1988) 282–284 (376 pages)

    The general topic and abstracts of an International Seminar organized on application of optimal control methods in meteorology is presented. The Seminar took place in Paris, France during 1987.

46. J. Steppeler, I.M. Navon and H.-I. Lu, "Finite-Element Schemes for Extended Integrations of Atmospheric Models," *Journal of Computational Physics*, **89**, (1990) 95–124

    The effect of the conservation of quadratic integral invariants by finite-element discretization schemes of the shallow-water equations as a representative model for long-term integrations of atmospheric models is investigated. Two finite-element models used by the atmospheric sciences community are investigated. Critical times for numerical nonlinear instability are related to the amount of minimal dissipation required to achieve stable long-term integrations.(Refereed).

47. I.M. Navon, P.K.H. Phua and M. Ramamurthy, "Vectorization of Conjugate-Gradient Methods for Large-Scale Minimization," *Journal of Optimization Theory and its Applications*, **66(1)**, (1990) 71–94

A novel approach to the vectorization of the nonlinear conjugate-gradient method applied to large-scale unconstrained minimization is put forward. Computational results and theory are presented using the Shanno-Phua robust memoryless quasi-Newton like conjugate-gradient for a set of large-scale meteorological problems. It is concluded that vector computers are advantageous for large-scale numerical optimization problems where local minima of nonlinear problems are to be found and the gradient and function evaluation take the bulk of the computational effort. (Refereed).

48. D.M. Legler and I.M. Navon, "VARIATM – A Fortran Code for Objective Analysis of Pseudo-Stress with Large-scale Conjugate-Gradient Minimization," *Computers and Geosciences*, **17(1)**, (1991) 1–21

The algorithms and code involved in performing a direct minimization approach to the objective analysis of pseudo-stress over the Indian ocean are presented. An ample documentation for the benefit of interested users is also provided. (Refereed).

49. I.M. Navon, F. Brown and D.H. Robertson, "Combined Simulated-Annealing and Limited-Memory Quasi-Newton Methods for Determining Structure of Mixed Argon-Xenon Molecular Clusters," *Computers and Chemistry*, **14(4)**, (1990) 305–311

In this paper we show how various limited memory quasi-Newton large scale unconstrained minimization methods are used to speed up the location of global minima of potential energy surfaces related to the structure of mixed Argon Xenon molecular clusters. Both a simulated annealing method and a finite-temperature lattice based Monte-Carlo method are accelerated by the various quasi-Newton methods. (Refereed).

50. I.M. Navon, "A Survey of the Status of Efficient Minimization Algorithms for Variational Data assimilation," in: International Symposium on Assimilation of Observations in Meteorology and Oceanography, eds. O.Talagrand and F.X. LeDimet, (World Meteorological Organization, 1990) 42–45 *Reviewed by the International Programme Committee of the W.M.O.*

A survey of efficient state of the art large scale minimization methods as well as numerical results serving as an illustration of their application in variational data assimilation are presented.

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    Variational 4-D data assimilation performed using the 3-D spectral model of the National Meteorological Center of U.S. using both computer generated data as well as real data is presented. The derivation of the adjoint model of the discretized NMC spectral model is also presented. The issues of optimal control as well as the optimization methods used in performing the descent for the assimilation problem are also discussed.

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160. M. Jardak and I.M.Navon, "Particle filter and EnKF as data assimilation methods for the Kuramoto-Sivashinsky Equation ," *In Early View, International Journal for Numerical Methods in Fluids*, (2009).

161. A.K. Alekseev and I. M. Navon, "An estimation of the sensitivity of numerical error norm 3 using adjoint model," *In galley proof to International Journal for Numerical Methods in Fluids* , (2009).

162. Santha Akella and I.M. Navon, " Different approaches to model error formulation in 4D-Var: a study with high resolution advection schemes ," *Tellus A*, **Vol 61A**, (2009) 112–128.

163. F.Fang ,C. C. Pain,I. M. Navon, G. J. Gorman, M. D. Piggott, P. A. Allison, and A. J. H. Goddard , "A POD goal-oriented error measure for mesh optimisation," *Accepted for publication to International Journal for Numerical Methods in Fluids*, (2009).

164. A.K. Alekseev and I. M. Navon, " Criteria of optimality for sensors location based on adjoint transformation of observation data interpolation error," *In Early View, International Journal for Numerical Methods in Fluids*, (2009).

165. Jacques Blum, Francois-Xavier Le Dimet, I. Michael Navon, "Data Assimilation for Geophysical Fluids," *Published in "Computational Methods for the Atmosphere and the Oceans",Elsevier, R. Temam and J. Tribbia Eds,Special Vol in Handbook of Numerical Analysis (P. G. Ciarlet, Editor)ISBN-13: 978-0-444-51893-4*, **14**, (2008).

166. I. M. Navon, "Data assimilation for Numerical Weather Prediction : a review. ," *Published in " Data Assimilation for Atmospheric, Oceanic, and Hydrologic Applications".Springer, Park, Seon K., Xu, Liang(Eds), 2009, XVIII, 475 p. 326 illus., Hardcover, ISBN: 978-3-540-71055-4*, (2009).

167. Juan Du, Jiang Zhu, Zhendong Luo and I. M. Navon , "An optimizing Finite difference scheme based on proper orthogonal decomposition for CVD equations.," *In Early View in Communications in Numerical Methods in Engineering* , (2009).

168. X. Chen and I.M. Navon, " Optimal Control of a Finite-Element Limited-Area Shallow-Water Equations Model. ," *Special Issue of STUDIES IN INFORMATICS AND CONTROL in honor of Dr Andrei Neculai* , **Vol 18, No 1**, (2009) 41-62.

169. X.Chen, I.M. Navon and F. Fang, "A dual weighted trust-region adaptive POD 4D-Var applied to a Finite-Element shallow-water Equations Model," *Accepted for publication in International Journal for Numerical Methods in Fluids*, (2009).

RESEARCH AND INTERNAL REPORTS–SOUTH-AFRICA

1. I.M. Navon, WISK 200 – ADI Solution of the Inverse Balance Equation over a Trapezoidal Domain by an Embedding Approach 23 (1976).

2. I.M. Navon, WISK 222 – Totally Implicit Integration of a Limited Area Grid Model of the Shallow-Water Equations 28 (1976).

3. I.M. Navon, WISK 225 – Application of Fourth-Order Accurate Differences to a Three-Parameter Baroclinic Model of the Atmosphere 34 (August, 1976).

4. I.M. Navon, WISK 228 – A Comparative Study of Three Numerical Variational Objective Analysis Techniques 34 (October, 1976).

5. I.M. Navon, WISK 240 – A Survey of Finite-Element Methods in Quasi-Linear Fluid Flow Problems 44 (January, 1977).

6. I.M. Navon, WISK 245 – The Semi-Implicit Time Integration Scheme for Barotropic and Baroclinic Models of the Atmosphere 61 (February, 1977).

7. I.M. Navon, WISK 260 – Application of Fourth-Order Accurate Differences to a Three-Parameter Baroclinic Model of the Atmosphere: Part II 23 (June, 1977).

8. I.M. Navon, WISK 265 – Algorithms for Solving Scalar and Block-Cyclic Tridiagonal Systems of Linear Algebraic Equations 29 (July, 1977).

9. G. Fairweather and I.M. Navon, WISK 269 – A Linear Alternating-Direction Implicit (ADI) Method for Solving the Shallow-Water Equations 20 (August, 1977).

10. I.M. Navon, WISK 278 – Application of a New Partly-Implicit Time-Differencing Scheme for Solving the Shallow-Water Equations 25 (September, 1977).

11. I.M. Navon, Int. Report: 97 – A Fourth Order Compact ADI Scheme for the Shallow-Water Equations in Conservation Law Form 11 (October, 1977).

12. I.M. Navon, TWISK 5 – ADIF, A FORTRAN IV Program for Solving the Shallow-Water Equations 20 (November, 1977).

13. I.M. Navon, Int. Report: 105 – Application of a Higher Order Compact Scheme to a Linear ADI Method for the Shallow-Water 9 (December, 1977).

14. I.M. Navon, TWISK 25 – A Nonlinear Alternating Direction Implicit FORTRAN IV Program for Solving the Shallow-Water Equations 24 (May, 1978).

15. I.M. Navon, TWISK 29 – A Finite-Element FORTRAN IV Program for Solving the Shallow-Water Equations 33 (May, 1978).

16. I.M. Navon, TWISK 33 – Finite-Element Simulation of the Shallow-Water Equations Model on a Limited-Area Domain 31 (June, 1978).

17. I.M. Navon, Int. Report: 123 – ADI Solution of the Inverse Balance Equation Over a Non-Rectangular Region 7 (July, 1978).

18. I.M. Navon and H.A. Riphagen, TWISK 57 – An Implicit Compact Fourth-Order Algorithm for Solving the Shallow-Water Equations in Conservation Law Form 47 (January, 1979).

19. I.M. Navon, SWISK 10 – (Ph.D. Thesis), Numerical Methods for the Solution of the Shallow-Water Equations in Meteorology 234 (June, 1979).

20. I.M. Navon, Int. Report: 233 – Preliminary Report on the Feasibility of the Cloud Modeling Project (In connection with the Bethlehem cloud seeding project) 19 (January, 1980).

21. I.M. Navon, TWISK 166 – Comparison Between a Variational Technique and a Modified Bayliss-Isaacson Method for Enforcing Conservation of Potential Enstrophy in Shallow-Water Equations Models 37 (July, 1980).

22. I.M. Navon, Int. Report: 278 – The Impact of GARP Global Data Sets (DST-5 and DST-6 on Predictability Degradation in the Southern Hemisphere (October, 1980).

23. I.M. Navon, "SWISK 22 – The Computer Implementation of an Implicit Capacitance Matrix Method Numerical Solution of Helmholtz' Equation over General Bounded Planar Domains," 23 (December, 1980).

24. I.M. Navon, Int. Report: 305 – Analysis of Evolutionary Error in Finite-Element Simulations of the Shallow-Water Equations (February, 1981).

25. I.M. Navon, Int. Report: 308 – The Effect of Global Data Sets on Predictability Degradation in the Southern Hemisphere (February, 1981).

26. I.M. Navon, Int. Report: 318 – Special Report on the NASA/Goddard Data Systems Tests (DST) Review Meeting (February 12–13, 1981) (March, 1981).

27. I.M. Navon, TWISK 227 – SHALL.4 – An Implicit Compact Fourth-order FORTRAN Program for Solving the Shallow-Water Equations in Conservation Law Form 20 (August, 1981).

28. I.M. Navon, Int. Report: 359 – FESW – A Shallow-Water Finite-Element System (September, 1981).

29. I.M. Navon, Int. Report: 361 – 'A Posteriori' Numerical Techniques for Enforcing Simultaneous conservation of Integral Invariants Upon Finite-Difference Shallow-Water Equations Models (September, 1981).

30. I.M. Navon, TWISK 246 – Numerical Solution of Partial Differential Equations, Volume 1 and 2 (January, 1982).

31. I.M. Navon, Int. Report: 393 – A Numerov-Galerkin Technique Applied to a Finite Element Shallow-Water Equations Model with Exact Conservation of Integral Constraints (February, 1982).

32. I.M. Navon, TWISK 268 – Combined Penalty-Multiplier Nonlinearly Constrained Optimization Methods for Enforcing Conservation of Integral Invariants in Shallow-Water Equations Models 30 (June 1982).

33. I.M. Navon, TWISK 276 – A Numerov-Galerkin Technique Applied to a Finite-Element Shallow-Water Equations Model With Enforced Conservation of Integral Invariants and Selective Lumping (September, 1982).

34. I.M. Navon, Int. Report: 595 – Report on a Year of Study at NASA/Goddard Laboratory for Atmospheric Sciences (Global Modeling and Simulation Branch) (23 March, 1983 – 15 March 1984) (October, 1984).

INTERNATIONAL CONFERENCE PRESENTATIONS

1) Fourth Conference on Numerical Weather Prediction of the American Meteorological Society, Silver Spring, Maryland, October 29–November 1, 1979.

2) Third GAMM Conference on Numerical Methods in Fluid Mechanics, DFVLR, Cologne, West Germany, October 10–12, 1979.

3) Eighth International Conference on Cloud Physics, Clermont-Ferrand, France, July 15–19, 1980.

4) Symposium on Thunderstorms and Related Research, Pretoria, South Africa, September 15–16, 1980.

5) International Conference on Finite-Element Methods, Pretoria, South Africa, March 17–18, 1981. "Analysis of Evolutionary Error in Finite-Element Simulations of the Shallow-Water Equations." Conference on Finite-Element Methods in South Africa publication, 1–29.

6) First Announcement of Opportunity Review, NASA Goddard Space Flight Center, Greenbelt, Maryland, February 12–13, 1981.

7) Fourth GAMM Conference on Numerical Methods in Fluid Mechanics, Paris, France, October 7–9, 1981 (invited lecturer).

8) Third International Seminar on Finite-Element Systems, Southampton University, England, September 23–25, 1981.

9) Fourth International Symposium on Finite-Element Methods in Flow-Problems, Tokyo, Japan, July 26–29, 1982 (invited lecturer).

10) International Conference on Finite-Element Methods and Design FEMSA/83, University of Cape Town, Cape Town, South Africa, January 11–12, 1983.

11) SIAM Conference on Numerical Optimization, Boulder, Colorado, USA, June 12–14, 1984 (invited lecturer).

12) Seventh Conference on Numerical Weather Prediction, Montreal, P.Q. Canada, June 17–20, 1985 (invited lecturer).

13) International Symposium on Variational Methods in Geosciences, Cooperative Institute for Mesoscale Meteorological Studies. University of Oklahoma, Norman, OK, October 15–17, 1985 (Conference Chairman and Contributor).

14) International Conference on Development and Application of Computer Techniques to Environmental Studies, Los Angeles, CA, November 19–21, 1986 (1 contribution).

15) International Conference on Industrial and Applied Mathematics, Paris, France, June 29–July 3, 1987 (Organizer of Symposium on 4-D Data Assimilation and Optimal Control Methods in Meteorology).

16) Fifth International Aerodynamic Seminar, Lehrgebiet Aerodynamik des Fluges, Aachen, West Germany, July 5–8, 1987 (invited talk).

17) SIAM 35th Anniversary Meeting, Denver, Colorado, U.S.A., October 12–15, 1987 (invited talk). "Finite-Element Method in Meteorological and Oceanographic Flows."

18) Eight AMS Conference on Numerical Weather Prediction, Baltimore, Maryland, U.S.A., February 22–26, 1988 (1 contribution).

19) Supercomputers and Large-Scale Optimization. Algorithms, Software and Applications. University of Minnesota, Computer Science Department, May 16–18, 1988 (contributed paper).

20) Molecular Mechanics and Molecular Dynamics, Tallahassee, Florida, April 4–8, 1988. Invited talk entitled "Quasi-Newton-Like Conjugate-Gradient Methods for Large-Scale Minimization and Their Application to Supercomputers."

21) Institute for Naval Oceanography, University Corporation for Atmospheric Research, NSTL, Mississippi. Invited talk entitled "4-D Data-assimilation Algorithms in Oceanography, " September 2, 1987.

22) European Center For Medium-Range Weather Forecasts. Invited seminar entitled "Conjugate-Gradient Methods for 4-D Data Assimilation in Meteorology, " June 26, 1987.

23) Nonlinear Dynamics of Rotating Magnetic Systems, Department of Mathematics, UCLA, Los Angeles. Invited talk entitled "Bounded-Derivative Approach For Simulating Magneto-Hydrodynamical Flows, " August 3–8, 1987.

24) Hebrew University of Jerusalem, Israel. Invited talk entitled "Four-Dimensional Data-Assimilation, " January 21, 1987.

25) Supercomputing 88, International Conference, Orlando, Florida, November 14–18, 1988. Contributed paper entitled "Vectorization of Conjugate-Gradient Methods for Large-Scale Minimization."

26) Supercomputers and Large-Scale Optimization International Workshop. Supercomputer Institute and Department of Computer Science, University of Minnesota, May 16–18, 1988. Invited talk.

27) International Conference on Computer Modelling in Ocean Engineering – Problems and Solutions in Coastal and Offshore Systems. Venice, Italy, September 19–23, 1988. Invited paper entitled "A Review of Finite-Element Methods for Solving the Shallow-Water Equations."

28) International Conference on Iterative Methods For Large Linear Systems, University of Texas, Austin, October 19–21. Invited paper entitled "A Benchmark comparison of the Performance of the ITPACKV Software Package on the ETA10 and CYBER 205 Vector SuperComputers."

29) 7th International Conference on Finite-Element Methods in Flow Problems. University of Alabama in Huntsville, April 3–7, 1989. Invited paper entitled "Aspects of Finite-Element Methods for Solving the Shallow-Water Equations."

30) SIAM Conference on Optimization. Boston, MA, April 3–5, 1989. Accepted paper entitled "Acceleration of a Simulated Thermal Annealing Method by a Q-N Like Conjugate-Gradient Method for Determination of the Structure of Mixed Argon-Xenon Molecular Clusters."

31) Conference on Preconditioned Conjugate-Gradient Methods, Catholic University of Nijmegen, Mathematical institute. Invited talk entitled "Numerical Experience with the NSPCG package." June 19-21, 1989.

32) Tenth Annual Golf of Mexico Information Transfer Meeting, New-Orleans, Louisiana, December 1989.Talk Entitled "Modeling of Oil-Spills in Florida Waters" With H.M.Cekirge, J. Sollohub and S. Nnaji.

33) International Symposium on Assimilation of Observations in Meteorology and Oceanography.Clermont-Ferrand, France, 9–13 July 1990. 2 Talks Entitled 1.) "4-D Data Assimilation in the N.M.C. Spectral Model." With X. Zou, J. Derber and J. Sela. 2.) "Application of a Conjugate-Gradient Method to Variational Assimilation of Meteorological Fields" with M.K. Ramamurthy.

34) Copper Mountain International Conference On Iterative Methods, Copper Mountains, CO, April, 1–5, 1990. Paper to be presented entitled "Preconditioned Conjugate-Gradient Methods for Solving Highly Discontinuous Problems on Vector Computers " with B. Holter, Dennis Morrow and T. Oppe.

35) Institute For Mathematics and its Applications.Workshop on Nonlinear Phenomena in Atmospheric and Oceanic Sciences. June 4–8, 1990.Invited talk entitled "Finite-Time Blow-Up in Finite-Difference and Finite-Element Models of the Shallow-water Equations"

36) Simon Fraser University, Department of Mathematics and Statistics, Burnaby, Vancouver, British-Columbia, Canada. August 3, 1990. Invited Talk entitled "Optimal Control of Partial Differential Equations : Application to Initial and Boundary Value Control of the Shallow-Water Equations."

37) Singapore SuperComputer Conference '90. December 11–12, 1990, Singapore. Invited Keynote Speaker in the area of "Supercomputer Applications in Weather Prediction".

38) Workshop on Automatic Differentiation of Algorithms: Theory, Implementation, and Applications, January 7-9, 1991, Hilton Hotel Breckenridge, Colorado. Invited Speaker. Topic of talk will center on "Obtaining the Adjoint of the NMC Spectral Model".

39) ICOTA '92 International Conference on Optimization Techniques and Applications, June 1992, Singapore. Invited Keynote Speaker, along with Profs Powell and Fletcher.

40) International Conference on Industrial and Applied Mathematics. Washington D.C., July 8–12, 1991. Invited Minisymposium Speaker.

41) ORSA Conference on Operations Research, May 12-15, 1991, in Nashville, Tennessee. Invited Speaker. Organizer : Prof Stephen Nash.

42) Invited Lecture, Department of Atmospheric Sciences, Hebrew University of Jerusalem. Jerusalem, Israel, May 6, 1991. Talk entitled "4-D Variational Data Assimilation"

43) Invited Lecture. NASA Goddard Space Flight Center and University of Maryland.Greenbelt, NASA Outstanding Summer Scientist Series Maryland, 10 June 1991.Title of the talk "Variational 4-D data Assimilation: Theory and Applications".

44) Invited Lecture.Department of Mathematics and Statistics. Simon Fraser University, Vancouver, British Columbia, Canada, May 24 1991.

45) Chairman of Session and Speaker. 13-th IMACS World Congress on Computation and Applied Mathematics.July 22–26, 1991. Trinity College, Dublin, Ireland.

46) Ninth Conference on Numerical Weather Prediction, Denver, Colorado, October 14-18, 1991. 3 Talks presented entitled: 1) "Variational Data Assimilation With the Direct and Adjoint Primitive Equations and Normal Mode Initializations"with X.Zou, J.Derber, D.Parrish and J.Sela, 2)"On the Effect of Gravity Oscillations, Boundary Control and Incomplete Observations in a Shallow-Water Equations Model with Applications to Variational Data Assimilation" with X.Zou and F.X. LeDimet and 3) "The Estimation of Systematic Model error Using variational Techniques"

with J.Derber, J.Sela and X.Zou. (In Preprints of Ninth Conference on Numerical Weather Prediction, Denver, Colorado, October 14-18, 1991.

47) National Institute of Statistical Sciences, Research Triangle Park, North Carolina. Invited Panelist on the topic ""Statistical Strategies in Environmental Modeling and Monitoring", December 8-9, 1991.

48) 11-th International Symposium on Finite Element Methods in South-Africa, Cape-Town 15-17 January 1992. Keynote Speaker invited by the University of Cape-Town.Delivered the Conference Opening Talk entitled "Domain decomposition of a Finite-Element Model of the Shallow-Water Equations".

49) Invited Speaker and Participant at the Institute of Mathematics and its Applications for the Summer Program on Environmental Studies, July, 13-24, 1992.

50) Invited Speaker at the Old Dominion University, Center for Coastal and Physical Oceanography, Norfolk, Virginia, Feb9-11, 1992. Title of the talk :"Variational Data Assimilation in Oceanography".

51) Invited Speaker at the Southeast Conference on Geophysical Fluid Dynamics. Tallahassee March 13–14, 1992.Title of the talk : "Variational data assimilation-an Optimal Nudging Applied in Atmospheric Sciences".

52) Invited speaker at Groupement de Recherche : Methodes Variationnelles en Meteorologie et Oceanographie, Toulouse, France, Meteo-France, 2–3 July, 1992.

53) Invited Speaker at Symposium entitled "Russia-U.S.A. Conference on Geophysical Wave - and-Vortex Systems: Dynamics, Data assimilation and Predictability." Rutgers University, Piscataway, N.J. 1 Sept–4 Sept 1992. Organized by Prof N.J. Zabusky and sponsored by NSF, Div of International Programs.

54) Invited Speaker, X-th International Conference on Computers in Chemical Research and Education ICCCRE), Jerusalem, Israel July 12–17, 1992 .

55) Invited Speaker at the Workshop on adjoint Applications in Dynamic meteorology, Asilomar Conference Center, Monterey, California, 23–28 August 1992.Presentations by myself and my collaborators included: 1. Zou, Navon and Sela - Variational data assimilation with threshold Physical Phenomena. 2.Wang, Navon and LeDimet - Second Order Analysis : Theory and Applications . 3.Li and Navon - Variational data assimilation with a semi-Lagrangian Semi- implicit global shallow-water equations model and its adjoint.
4.Navon, Zou and F.X. LeDimet - An optimal Nudging Data assimilation Scheme using parameter estimation.

56) Invited Speaker Yale Mintz Memorial Symposium on Climate and Climate Change, Jerusalem, Israel, 28–31 December, 1992.Title of presentation " An adjoint Sensitivity Analysis Study for Northern Hemisphere Blockings Using a Two-Layer Isentropic Climate Model".

57) Invited Seminar Speaker at the Assimilation of Meteorological and Oceanographical Observations, Theory, Methods and Related Problems. International School, August 2-27, 1993, La-Garde, Near Toulon, France.

58) Member of Scientific Committee and Invited Speaker at the Workshop on High Performance Computing in the Geosciences, June 21–25, 1993 Centre de Physique Des Houches, Chamonix, France. Sponsored By IMAG, CNRS and NATO Advanced Study Institute.

59) Contributed Talk at the Seventh International Conference on Domain Decomposition Methods in Scientific and Engineering Computing which took place at Penn State University, University Park, Pa, October 27–30, 1993. Presentation was entitled "Parallel Domain Decomposed Preconditioners for the Finite-Element Shallow-Water Flow Modeling".

60) Invited Speaker at the International Summer School on Assimilation of Meteorological and Oceanographic Observations. Theory, Methods and Related Problems, which took, place August 2-27 1993 at the La Garde near Toulon, France. Talks included a Seminar as well as a tutorial. The workshop was sponsored by IMAG, CNRS and NATO Advanced Study Institute as well as by NASA, NSF.

61) Invited Speaker at the University of Padova, Department of Pure and Applied Mathematics, September 6-September 21, 1993, delivering a series of 10 invited talks covering topics of Domain- Decomposition, Parallel Processing and Preconditioning methods.

61) Invited speaker and consultant of the German Weather Bureau (Deutscher Wetter Dienste- DWD) from Nov. 16-Nov 19, 1993. Delivered an invited talk entitled "Optimal Nudging Data Assimilation using Optimal Parameter Estimation."

62) Invited speaker at the Rhein-Westfalia Polytechnic Institute (RWTH) in Aachen, Germany in the Research Division of the Department of Aerodynamics of Fluids and was hosted by the Director of the Institute, from 19-22 Nov. 1993. The title of the talk was " Variational Data Assimilation, Parameter Estimation and Sensitivity Analysis Using Adjoint Techniques".

63) Invited speaker at the Institute for Computer Applications in Science and Engineering (ICASE) at NASA Langley Research Center, Hampton, Virginia, by Director, Prof. Y. Hussaini., on March 25-26, 1994. Talk related to application of optimal control of distributed parameter systems for a variable resolution finite element model of the shallow water equations.

64) Invited Speaker at the 2-nd Workshop on Adjoint Applications in Dynamic Meteorology.2-6May 1994, Visegrad, Hungary. Delivered 5 talks with collaborators.

65) Invited Speaker at the Workshop on High Performance Computing and Semi-Lagrangian Transport at NASA Goddard Space Flight Center, May 19 and May 20, 1994 on "Aspects of Parallelization of variational Data assimilation with the NASA/ Data Assimilation Office using a Semi-Implicit and Semi-Lagrangian Model."

66) Invited speaker and chair of a Session entitled "Adjoint systems and Variational Analysis "at the 19-th Numerical Weather Prediction International Conference, July 17-22, 1994, Portland, Oregon. The conference was sponsored by the American Meteorological Society. Also nominated and acted as a member of Program Committee of the same Conference.

67) Invited speaker and consultant for a series of Tutorial Seminars at Naval Research Laboratory, Monterey California, August 1994 as part of an effort to develop variational data assimilation for the Navy model.

68) Invited Speaker at the Andre J. Robert Memorial Symposium on Numerical Methods in Atmospheric and Oceanic Sciences, University of Quebec at Montreal, 5-7 October, 1994. He presents a paper co-authored with Drs W. Yang, SCRI Research Associate and Dr Yong Li from General Science Corporation and NASA/Goddard Space Flight Center, Data Assimilation Office entitled" Variational Data Assimilation with NASA/GLA Semi-Lagrangian Semi-Implicit GCM's "

69) Invited Speaker at the Second International Symposium on Assimilation of Observations in Meteorology and Oceanography. WMO/TD-No 651, Tokyo 13-17 March 1995 where he presented 5 papers with collaborators.

70) Speaker at the Third International SIAM(Society for Industrial and Applied Mathematics) Conference on Mathematical and Computational Issues in the Geosciences, February 8-10, 1995, San Antonio Texas. He presents a paper co-authored with Dr. W. Yang, SCRI Research Associate entitled" Variational Data Assimilation with NASA/GLA Semi-Lagrangian Semi-Implicit GCM's " in the framework of the Session on Atmospheric and Oceanic Methods.

71) Invited Speaker at the Third International Congress on Industrial and Applied Mathematics, Hamburg, Germany July 3-7, 1995. This Congress reunited 3000 industrial and applied mathematicians from all over the world. He presented the opening paper in a Minisymposia on the topic:Aerodynamic Optimization and Drag Reduction. The paper was entitled " Large -scale unconstrained and constrained optimization methods and their applications".

72) Invited Speaker at the International Conference on Computational Engineering July 30-August 3, Mauna Lani, Big Island of Hawaii, sponsored by U.S. Association of Computational Mechanics and Japan Society of Mechanical Engineers. He delivered the Keynote talk in the Session on Environmental Problems entitled : "Variational Data assimilation, Optimal parameter estimation and sensitivity analysis for environmental problems"

73) Invited Keynote Speaker at the Ninth International Conference on Finite Elements in Fluids-" New Trends and Applications" which was held in Venice, Italy , 15-21 October 1995 The international Conference was sponsored by IACM -International Association for Computational Mechanics, ECCOMAS -European Community on Computational Methods in Sciences and Dassault Aviation, France amongst others. Apart from the Key-note talk Prof. Navon delivered 2 other talks at the Conference co-authored by Dr. Jieping Zou, SCRI, FSU and another one co-authored by Dr. X. Zou, NCAR and Dr. K. Zhu, University of Chengdu, P. R. China.

74) Invited Speaker with Dr Weiyu Yang (SCRI) at the 6-th International Symposium on Computational Fluid Dynamics at Lake Tahoe Nevada, September 4-8, 1995. They delivered a talk entitled "A New Hessian Preconditioning Method Applied to Optimal Control Variational Data Assimilation Experiments using NASA SLSI Global S-W Model and the GEOS-1 GCM." The international Symposium was sponsored by NASA Ames, NASA Lewis, the Army Office of Research and by the Japan Society of CFD.

75) Keynote talk in a Workshop on " Environmental and Weather Prediction : Optimal Control and HPC issues " at the Center for the Control of Fluids, Naval Command Control and Ocean Surveillance Center, San Diego, California, September 12, 1995. His talk was entitled " Variational Data assimilation, Optimal parameter estimation and sensitivity analysis for environmental problems".

76) Speaker at the Second International Workshop in Computational Differentiation held in Santa-Fe, New-Mexico, February 12-14, 1996.Title of talk "Second order ANALYSIS in Variational Data Assimilation" with Francois Le Dimet.

77) Invited Speaker and Consultant to CENTER OF EXCELLENCE IN SPACE DATA INFORMATION SCIENCES at NASA/GSFC. Title of talk "Variational Data Assimilation, Optimal Parameter Estimation and Sensitivity Analysis for Climate and environmental Problems" April 22-23, 1996.

78) Invited Speaker at MAFELAP 96 -Ninth Conference -The Mathematics of the Finite Elements and Applications. Brunel University Uxbridge, UK 25-28 June 1996.Title of Talk "Optimal Control with a Variable Resolution Finite-Element Shallow Water Equations Model"

79) Invited Speaker and Chairman of 2 Sessions at the Third Asian -Pacific Conference on Computational Mechanics, Seoul, Korea. Title of invited talk "Practical and Theoretical Aspects of Adjoint Parameter Estimation in Meteorology and Oceanography".September 16-18, 1996.

80) Invited Speaker for a series of lectures at the Chuo University, Japan. Host;Prof Matsuto Kawahara, Chair Dept of Civil Engineering, Chuo University, Tokyo, Japan. Sept 19-October 2, 1996.

81) Presented invited Seminar Talk at the Dept of Mathematics and Statistics at the University of Pittsburgh, March 20-22, 1997.

82) Presented 4 contributions and chaired a Session entitled " Numerical Aspects of the development and Validation of Tangent Linear and Adjoint Models " at the Third Workshop on Adjoint Applications in Dynamic Meteorology 16-20 June 1997, Lennoxville, Quebec, Canada sponsored by the Canadian Atmospheric Environment Service.

83 Served as a consultant for 2 days December 89, 1998 at the Center for Excellence in Space Data and Information Sciences (CESDIS) at NASA /GSFC and Space Data Computing Division and presented an invited Seminar Entitled" Strategies for four-dimensional data assimilation using the FSU Global Spectral Model with its full physics adjoint".

84 Fifth SIAM Conference on Mathematical and Computational Issues in the Geosciences March 24-27, 1999 San Antonio, TX - Joint meeting with PP99. Recent Progress in Atmospheric Data Assimilation and Retrieval - Part I of II. MS23. 2 contributions: Friday, March 26 a) 11:00-11:25 Strategies for Implementation of 4D-Var Using Adjoint Models with Physics. Presented by Ionel Michael Navon and Zhijin Li, Florida State University. b) 2:30-2:55 Relationship of 4D-Var with the Kalman Filter and Smoother Presented by Zhijin Li and I. M. Navon, Florida State University

85 2. Sixth SIAM Conference on Optimization (OP99) May 10-12,1999, Sheraton Spirit of Atlanta Hotel, Atlanta, GA Tuesday, May 11, MS23 Numerical Methods in Optimal Design and Optimal Control. 4:30-4:55 Performance of Efficient Minimization Algorithms as Applied to Models of Peptides and Proteins. Presented by: I. Michael Navon, C. Baysal and H. Meirovitch, Florida State University.

86 Third WMO International Symposium on Assimilation of Observations in Meteorology and Oceanography. 7 - 11 June 1999, Quebec City, Canada a) 16:50-17:10: Impact of parameter estimation on the performance of the FSU Global Spectral Model using its full physics adjoint. Speaker: Ionel Michael Navon b) Singular vectors and adaptive observations Speaker: Yan Yang (with I.M.Navon and Ricardo Todling) c) Strategies for implementation of 4D-Var using adjoint models with full physics adjoint. Speaker: Ionel Michael Navon

87 2000 SIAM Annual Meeting, Puerto-Rico, July 10-14,2000. MS27 Advances in Optimal Flow Control - Part II 5:00-5:25 Optimal Control for Flow Around a Rotating Cylinder C. Homescu, I. M. Navon, M. Y. Hussaini, and Zi Li, Florida State University,USA. MS33 Advances in Optimal Flow Control - Part III of IV 1:30-11:55 Optimal Control of Karman Vortex Shedding with Unsteady Two-Dimensional

Navier-Stokes Equations and Their Adjoints. by Zhijin Li, I. Michael Navon, M. Y. Hussaini, and F. X. Le Dimet, Florida State University, USA.

88 Tokyo Workshop of Information Technology in Hydroscience and Engineering. Invited Speaker of the Workshop. 21-22 September 2000 KORAKUEN CAMPUS of CHUO UNIVERSITY TOKYO, JAPAN. I. M. Navon: Optimal Control of the Unsteady Navier-Stokes Equations.

89 Seminar of the Lokal Modell -User Group BTZ Langen,Germany: 21. - 23. May 2001. Presentation: I.M. Navon, A Perfectly Matched Layer Formulation for the Nonlinear Shallow Water Equations Models: The Split Equation Approach. Application to mesoscale models.

90 SIAM Conference on Control and Annual Meeting. Saturday, July 14,2001,San Diego, California:
Control of Fluids: Theory and Numerics, Part III
Optimal Control of Flows with Shock Discontinuities (Euler Equations) by Chris Homescu and I.M. Navon.
Model Reduction of Large-scale Systems
An Overview of Data Assimilation Techniques in Meteorology by Michael Navon.

91 Invited Speaker at the Sensitivity Analysis Workshop 2001, August 16-17, 2001, Wente Vineyards, Livermore, CA. Topic: Sensitivity Analysis for Large-Scale Scientific Simulations Hosted by: Center for Applied Scientific Computing Sponsored by: ASCI Institute for Terascale Simulation and Institute for Scientific Computing Research.Lawrence Livermore National Laboratory.

92 Invited Speaker at European Geophysical Society XXVII General Assembly, Nice, France, 22-26, April 2002
Session: Advances in numerical weather prediction: data assimilation, regional and global models, ensembles, and operational methods Convener: Huang, X.; Co-Convener(s): Kalnay, E.
Presentation:Adaptive observations in the context of 4D-Var data assimilation. (with DAESCU , D.N.)

93 Session Organizer and Speaker at: The Sixteenth Triennial Conference of the International Federation of Operational Research Societies, hosted by the UK Operational Research Society 8 - 12 July, 2002 , University of Edinburgh ,Edinburgh, Scotland.
Invited session Venue: AT-7. Friday July 12, 2002
Session Chair: Navon, Ionel Michael
Session: FD13 Large scale optimization in optimal control and molecular dynamics
4 Lectures presented
1) Comparison of advanced large-scale minimization algorithms for solving inverse problems, Navon, Ionel Michael, Florida State University, United States;with Alekseev, Aleksey K.
2) An analysis of the enriched optimization methods for variational data assimilation, Daescu, Dacian Nicolae, IMA, Univ. of Minnesota, United States; Navon, Ionel Michael
3) Global and local optimization methods for protein systems, Das, Bedamati, University of Pittsburgh, United States; Ozkan, S. Banu; Meirovitch, Hagai; Navon, Ionel Michael
4) Truncated-Newton based Training Algorithm for Neural Networks ,with Al-Haik, Marwan S., Florida State University, United States; Navon, Ionel Michael

94 IMA-Institute of Mathematics and its Applications : Mathematics in the Geosciences

Invited IMA Speaker Workshop 10: Data Assimilation in the Oceanic and Atmospheric Sciences, April 29- May 3, 2002
I. Michael Navon (Program Director and Professor Department of Mathematics and School of Computational Science and Information Technology ,Florida State University)
Presentation: The Analysis of an Ill-Posed Problem Using Multi-Scale Resolution and Second-Order Adjoint Techniques http://www.ima.umn.edu/geoscience/abstracts/4-29abs.html

95 2003 SIAM Conference on Computational Science and Engineering February 10-13, 2003, Hyatt Regency Islandia Hotel & Marina, San Diego, CA 1. Application of Advanced Large-Scale Minimization Algorithms for Inverse Problems and Data Assimilation. Ionel Michael Navon, Florida State University; Dacian N. Daescu, University of Minnesota, Minneapolis; Aleksey Alekseev, RSC ENERGIA Corporation, Russia. 2. Adjoint Sensitivity and Optimal Control for Flow with Discontinuities Ionel Michael Navon and Chris Homescu, Florida State University and UCSB/CSE.

96 2004 Annual SIAM Conference, Portland Oregon. Lecturer at SIAM annual meeting Portland, Oregon 2004 and organized there a two part Minisymposium on Data Assimilation and Predictability for Atmospheric and Oceanographic Modeling.(With Dacian Daescu and Adrian Sandu) Part I of II (MS49)
A Study of Model Error Using the Lin-Rood Shallow Water Finite Volume Model in Adjoint Mode Ionel Michael Navon and Santha Akella, Florida State University.

97 Invited Talk University of Maryland November 2005. Center for Scientific Computation and Mathematical Modeling (CSCAMM) at the University of Maryland "On adjoint error correction and bounding using Lagrange form of truncation term"

98 Invited Talk: University of Portland, Dept of Math and Statistics, Feb 21-23 2006. "On adjoint error correction or goal-oriented methods". The Maseeh Mathematics & Statistics Colloquium Series.

99 Virginia Polytechnic Institute and ICAM (Hosted by Prof Adrian Sandu) April 2006 Topic: Variational Data Assimilation and POD.

100 Invited Talk: Imperial College, London. July 2006: Reduced order modelling for inverse problems.

101 Invited Talk, National Oceanographic Center, Southampton June 2006 Reduced order modelling in Oceanography.

102 Invited Talk: DARC-NERC, University of Reading, Joint Mathematics and Meteorology Departments Center of Excellence, June 2006: 4-D VAR topics.

103 International Workshop organized with Dr M. Zupanski on: Predictability, Observations, and Uncertainties in Geosciences, 13-15 March 2006, Tallahassee, Florida SCS Seminar room, 4-th floor, Dirac Science Library, Florida State University .Supported by SCS and NSF.

104 2007 SIAM Conference on Computational Science & Engineering (CSE07) February 19-23, 2007 Hilton Orange County/Costa Mesa, Costa Mesa, California.
Minisymposium organizer: Topics Recent Advances in Data Assimilation for Atmospheric and Oceanographic Modeling - Part I of II Organizers Dacian Daescu, I. Michael Navon and Adrian Sandu.

104 International Workshop on INDUSTRIAL APPLICATIONS OF LOW ORDER MODELS BASED ON PROPER ORTHOGONAL DECOMPOSITION (POD). Institut de Mathematiques de Bordeaux UMR 5251 BORDEAUX March 31 - April 02 2008 (Invited Speaker)

MAJOR RESEARCH ACTIVITIES

FUNDED NSF RESEARCH PROJECT 1988-1991

"Determination of the Adjoint Models of the NMC Global and NGM Models and Their Application to 4-D Data Assimilation, " I.M. Navon (Principal Investigator), F.X. LeDimet, K. Johnson, and M. Ramamurthy (Co-principal Investigators); Project Period, May 1, 1988 to April 30, 1991. Amount Requested in U.S. Dollars: $446, 627. Grant approved, March, 1988. Start of project: June, 1988. NSF Grant : ATM-8806553

PARTICIPATION IN EDUCATIONAL NSF FUNDED PROPOSAL

Together with Professor Blumsack, this coming summer we plan to teach a group of gifted undergraduate students from various universities in the U.S., involving them in research projects.
A grant from the Research Experience for Undergraduates Program in the NSF has already approved this proposal and allocated 35, 000 dollars for this scope.
We intend to teach the students how to solve partial differential equations describing fluid dynamics phenomena using the I.M.S.L. newly developed expert system PDE solver (PDE/PROTRAN) for solving time dependent partial differential equations which has graphic display capabilities for 2-D and 3-D graphics.
The code will be acquired by SCRI from I.M.S.L. and be made available on the Cyber-850 RAI.

GRANT FROM AIR FORCE OFFICE OF SCIENTIFIC RESEARCH, 1988-1991

A project to implement adaptive mesh refinement in a barotropic global finite-element model of the shallow-water equations.
The grant is AFOSR 89-0462 and consists of 85, 000 dollars per annum for 3 years. The P.I. is Prof Richard Pfeffer and I am a Co-P.I. along with Profs. Lou Howard and Ruby Krishnamurti.

FUNDED JOINT U.S.-FRANCE N.S.F. INTERNATIONAL TRAVEL PROGRAM 1991-1993

A proposal for travel related research to be conducted under the sponsorship of the National Science Foundation has been submitted with Prof J.J. O'Brien on the U.S. part and Profs LeDimet, Talagrand, Verron and Nouallier to be sponsored by the Centre National des Recherche Scientifique on the French counterpart.
The title of the proposal is : Variational Data Assimilation Using Optimal Control Methods. Amount requested U.S. $18, 250.
This proposal has been approved for funding by NSF starting February 1991.

FUNDED NATIONAL AERONAUTICS AND SPACE ADMINISTRATION RESEARCH GRANT, 1991-1993

A research proposal entitled "Variational Data Assimilation with the semi implicit Semi-Lagrangian Shallow-water equation model on the sphere using a multigrid solver was approved for funding for 2 years by NASA Headquarters , starting June 1991.
I am the P. I. while Prof Fred Semazzi of North Carolina State University, Dr Winston Chao of NASA/GSFC and Dr Xiaolei Zou of SCRI/FSU are Co-Principal Investigators.
The total amount funded for this 2 year project is $229, 906.

FUNDED NSF RESEARCH PROJECT 1991-1994

A research proposal entitled "Variational Data Assimilation with the NMC Spectral Model" has been approved for funding by NSF for 3 years starting June 1991.
The total amount funded by this grant award is $376, 904.00
I am the Principal Investigator while Prof Tamar Schlick of the Courant Institute for Mathematical Studies and Dr Xiaolei Zou of SCRI/FSU are Co-Principal Investigators.

CONSULTANT TO C.A.P.S.-UNIV OF OKLAHOMA
During summer 1989 I was invited by Prof Douglas K. Lilly to consult on topics of the application of the adjoint method for their mesoscale model. C.A.P.S. is a center of excellence established by NSF at the University of Oklahoma, Norman, Oklahoma.
CONSULTANT TO FRENCH NAVY
Consulting on an yearly contract basis with the French Navy in view of deriving system of satellite altimeter data assimilation in a limited area multilayer ocean model. (1995-).

Cooperative Exchange with the Joseph Fourier University - Institute for Applied Mathematics
Several French students (2 every year) have visited FSU/SCRI to specialize on computational mathematics topics during a 4-months specialization period. We are working on formalizing this exchange at University level.
Member of National NSF Panel of Experts to Judge and Site Visit the OKLAHOMA Science and Technology Center (CAPS)

Encyclopedia of Applied Physics
Invited to write survey article on Numerical Analysis in this Encyclopedia sponsored by American Institute of Physics, Deutsche Physikalische Gesellschaft, Japan Society of Applied Physics and Physical Society of Japan, published by VCH Publishers Inc., 1992.

SERVICE TO COMMUNITY

Chairman of S.C.R.I. Committee

Chairman of the SCRI Personnel Advisory Committee during 1987–1988. Devoted time to recruitment and scanning of potential candidates for Software Librarian position as well as to allocation of SCRI funds for supporting graduate students.

Development and Implementation of the Purdue ELLPACK package on the FSU Supercomputer, 1987–1988.

ELLPACK is a software expert system for solving elliptic partial differential equations. An ELLPACK Primer Manual (276 pages) was written in order to help first-time users in the understanding and application of the full capabilities of ELLPACK for solving 2- and 3-D elliptic problems. This work was recognized by the Professor J. Rice as the best rendition of ELLPACK.

Invited participant in panel of world experts on "The Future Numerical Weather Prediction Operational Systems, " Washington, NMC, February, 29, 1988.

TESTING AND BENCHMARKING OF NEW MATHEMATICAL SOFTWARE

Benchmarking and alpha-testing of numerical optimization software E04DGF – developed by Numerical Algorithms Group, for the new MARK-12 update of the NAG Mathematical Software Library, 1988.

Benchmarking and testing of ITPACKV-205 – a software package for iterative solution of large systems of linear equations resulting from the discretization of elliptic partial

differential equations, developed at the Center for Numerical Analysis, University of Texas at Austin, 1988.

REVIEWER OF DOE, NASA, NSF AND NRC GRANT PROPOSALS

Review of DOE proposal by Professor Watson and Professor Ribbens – entitled "Parallel Mathematical Software, " 1988.

Review of DOE proposal by Professor Peter Salamon– entitled "The Demon Algorithm" 1990.
Reviewed yearly about 15 NSF, NASA and DOE proposals. (1991-1996)

Review of NSF proposal by Professor Hoffman and Professor Louis on 4-D Data Assimilation (Atmospheric Environment Corporation), 1988.

Review of NASA proposal submitted by Prof Grace Whaba and Prof Don Johnson, 1991.

Review of Natural Sciences and Engineering Research Council of Canada proposal submitted by Prof Elena Croitoro, Dept of Mathematics, University of Western Ontario, 1991.

EDITOR, JOURNAL FOR NUMERICAL LINEAR ALGEBRA WITH APPLICATIONS 1991-1999
Appointed to the editorial board of this new journal appearing since mid 1991 and with approval of the Publisher, World Scientific Co, Inc. Chief Editor is Professor Owe Axelsson.

EDITOR, Computational Fluid Dynamics Journal 1992-1999
Appointed to the editorial board of this new journal appearing since mid 1992 and with approval of the Publisher, Japan Society of Computational Fluid Dynamics and the Chief and Managing Editor is Professor Koichi Oshima.

EDITOR, MONTHLY WEATHER REVIEW, 1991-1994
Appointed Editor in charge of papers in Numerical Weather Prediction of MWR from 1991 and with approval of the Publisher, American Meteorological Society. From 1991-1994.

Associate EDITOR, MONTHLY WEATHER REVIEW 2001–

EDITOR, International Journal for Numerical Methods in Fluids 2008–

GUEST EDITOR OF INTERNATIONAL JOURNALS

Guest-Editor of Computers and Mathematics with Applications on the topic: Finite-Element Methods in Meteorological Flows. Vol. 16, No. 2–3, 1988.

Guest-Editor of Computers and Mathematics with Applications on the topic: Vectorization of Finite-Element Methods in Fluid Flows (with B. Neta), 1989.

Guest-Editor of Computers and Mathematics with Applications on the topic: Variational and optimal-Control Methods in Geophysics (with F.X. LeDimet), 1989.

Guest-Editor of Dynamics of Atmospheres and Oceans in charge of Special Issue honoring Prof Richard Pfeffer on his retiring from position of Director of GFDI. (1995–1997) The special issue comprised of 750 pages and 40 reviewed articled appeared as Volume 27, Nos 1–2, January 1998.

Guest-Editor of International Journal of Computational Fluid Dynamics in charge of Special Issue honoring Prof Mutsuto Kawahara on his 60-th birthday.
This Special issue will appear shortly and is comprised of 10 original articles in topics of optimal control,numerical optimization and finite element methods.(2002–2003).

BOOKS IN PRESS

Sensitivity and Uncertainty Analysis, Part II: Applications to Large-Scale Systems. by Dan Gabriel Cacuci, Mihaela Ionescu-Bujor, I.M. Navon Edition: Ring-bound, 368 pages, Chapman-Hall/CRC Press(Appears May 16, 2005), ISBN: 158488116X

Sensitivity and Uncertainty Analysis: Data Adjustment and Assimilation, Volume 3, by Dan Gabriel Cacuci, I.M. Navon and Mihaela Ionescu-Bujor Chapman & Hall/CRC, Boca Raton, 2006.

ORGANIZER OF INTERNATIONAL CONFERENCE ON FINITE-ELEMENTS

Organizer of an International Conference on Finite-Elements and Boundary Elements in Geosciences, to take place at the Naval Postgraduate School, Monterey, California, late 1991 or beginning 1992. With Profs Beny Neta, Naval Postgraduate School, and Prof R. Vichnevetsky, Rutgers University.

LEADER OF WORKSHOP ON LARGE-SCALE MINIMIZATION

Invited by Argonne National Laboratory to lead a Workshop in large-scale minimization in meteorology. This workshop is part of a program to explore application of optimization techniques in several large-scale application areas. The workshop will take place on February 19-20, at the Mathematics and Computer Science Division, Argonne National Laboratory.

Invited Speaker by the Institute for Mathematics and its Applications
Invited to deliver a talk at the Workshop on Nonlinear Phenomena in Atmospheric and Oceanic Sciences, June 4–8, 1990, as part of IMA 1989-1990 program on Dynamical Systems and their Applications.

Keynote Speaker Singapore Supercomputer Conference '90
Invited by Organizing Committee as keynote speaker in the area of "Supercomputer Applications in Weather Prediction" at the Singapore Supercomputer Conference '90 which will be held from 11–12, December 1990 in Singapore.

Keynote Speaker Singapore ICOTA '92 International Conference on Optimization Techniques and Applications, June 1992, Singapore.

Keynote Speaker at the 11-th International Symposium on Finite Element Methods in South-Africa, Cape-Town 15-17 January 1992

Keynote Speaker at the Ninth International Conference on Finite Elements in Fluids-" New Trends and Applications" which was held in Venice, Italy , 15-21 October 1995

DISTINGUISHED SCIENTIST OF NASA/GSFC

Invited by NASA/GSFC to be a summer distinguished visiting scientist in the framework of the 14-th Annual Summer Visiting Scientist Seminar Series.

CHAIRMAN OF SEARCH COMMITTEE

Chairman of Search Committee of S.C.R.I. for Outstanding Mathematical Scholar, 1988.

PEER REVIEWER FOR MATHEMATICAL TENURE COMMITTEES

Peer reviewer for evaluating qualification for tenure of:
Professor Beny Neta, Department of Mathematics, Naval Postgraduate School, Monterey, CA;
Professor Lazar Trachtenberg, Department of Electrical and Computer Engineering, Drexel University, Philadelphia, PA. 998

REVIEWER FOR SCIENTIFIC JOURNALS

a) Monthly Weather Review

b) Journal of Computational Physics

c) Computers and Mathematics with Applications

d) Computing Reviews Association for Computing Machinery

e) Journal of Geophysical Research

f)International Journal for Numerical Methods in Fluids.

g)Computers and Geosciences

h)Communications in Applied Numerical Methods

i) Computer Methods in Applied Mechanics and Engineering.

j)Journal of Numerical Linear algebra with Applications.

k) Computational Fluid Dynamics Journal

l) Tellus

m) Computers and Chemistry

n)Journal of Physical Oceanography

o)Computers in Physics

p)Association of Computing Machinery-Transactions on Mathematical Software.

DEVELOPMENT OF NEW COURSES FOR MATHEMATICAL CURRICULUM

Numerical Solution of Partial Differential Equations – MAD 5739, Parts 1 and 2.

Finite Element Galerkin Methods.
This involved introduction of new textbooks, development of an educational software library and development from scratch of the theoretical presentation of the finite-element method. etc.

Numerical Optimization.

A full flesh optimization software library has been developed and made available to the students for the purpose of this course, which in the future is to become a part of the curriculum of Applied Mathematics.
A novel interactive Blackboard based Numerical Optimization (MAD 5420) based on interaction of the student with hand on access to modern numerical optimization state of the art content, modern software libraries, illustrations and encouraging software

development by the student. Comprises unconstrained and constrained optimization, as well as genetic algorithms, fast simulated annealing and global optimization via neural networks.
The course puts the accent on developing knowledge and practical implementation of algorithms in both unconstrained and constrained large-scale nonlinear programming.

Computational Fluid Dynamics

The course involves computational methods in both incompressible and compressible flow and exposes the students to hands-on illustrative uptodate CFD software. Vols. 1 and II of Clive Fletcher's book and software were used.

Computational Linear Algebra
This course involves new iterative methods accelerated and preconditioned for the solution of large-scale symmetric and non-symmetric systems of linear algebraic equations.

Introduction to Numerical Analysis

Numerical Analysis Part 1 and Part 2

NUMERICAL OPTIMAL CONTROL OF PARTIAL DIFFERENTIAL EQUATIONS: THEORY AND APPLICATIONS

Nonlinear evolution equations are adequate models for problems arising in many modern applications. We focus our attention on optimal control problems governed by partial differential equations with the aim of discussing first a theoretical approach followed by numerical methods necessary in computerizing optimal control processes. Several numerical and computational examples are worked out in detail. Study of this subject is at the interface of at least the following fields:
Nonlinear Partial Differential Equations,
Functional Analysis,
Numerical Solution of Partial Differential Equations
Nonlinear Programming

Multidisciplinary Design Optimization (MDO)

Our proposed approach is based on the optimization of the whole system trough the optimization of its subsystems.
The design criteria of the subsystem can implicitly affect the performance criteria of the system as a whole , while, on the other hand there will be design criteria that will be calculated both the whole system and its subsystems.
There are one or several design criteria $\Phi_\nu(\alpha^{(i)})$ of the i-th subsystem (part of the whole criteria vector) that dominate corresponding criteria of the other subsystems. Here $\alpha^{(i)}$ is the i-th subsystem vector of design variables corresponding to the vector α.
This part involves multi-criteria parameter identification at the level of equations of the model and also involves taking into account differential functional constraints.
In order to save time as the dimension r of the design variable space gets larger - it is advisable to use methods for reducing dimensionality of design variable space by eliminating *insignificant* design variables - i.e. those not perceptibly influencing values of the design criteria. This can be done via either a forward or an adjoint sensitivity analysis or through a regression analysis technique.
The general multi-objective design optimization problem deals with a constrained design variable space where a functional $\mathcal{F}$ of an objective function f_j is subject to vector equality or inequality constrains and we aim at determining the achievable domain in objective function space i.e. to find values of z^* in the constrained design

variable space yielding values $f(z^*)$ in objective function space that are "optimal" in some sense.
Pareto optimality is a useful concept for multi-objective design problems since it defines a domain of non-dominated solutions on the boundary of the feasible domain.

EXTERNAL EXAMINER OF PH.D. THESIS

1) Appointed by the University of South-Africa, Department of Physics Pretoria, South-Africa as External examiner of a Ph. D. Thesis in Physics entitled " A Model Simulating Complex Topography and a Three Dimensional Wind Field" by H.F. B. Minnaar. Major Professor: Dr. G.W. Reuter (June 1989).

2) Appointed by the Dean of Arts and Sciences of Simon Fraser University, Department of Mathematics, as sole external examiner of a Ph.D. Thesis in Applied Mathematics by Mr. Song. Major Professor: Prof. Robin Willmott Lardner (Defense of Thesis was held August 1990).

3)Appointed by the Dean of Arts and Sciences of Simon Fraser University, Department of Mathematics, as sole external examiner of a Ph.D. Thesis in Applied Mathematics by Mr. Salil Das. Major Professor: Prof. Robin Willmott Lardner (Defense of Thesis was held May 1991.)

External Examiner of 2 Ph.D. Theses in Oceanography and 4-D Variational data assimilation at the University Joseph Fourier, Grenoble France, 1994- 1995.

MEMBERSHIP ON PH.D. COMMITTEES

1) Mr. Jeffrey Whittaker 2) Mr. Richard Bertram 3) Mr. Young 4) Vikram Mehta 5) David Legler 6) Ole Smestead 7) Young Youn
Mr. David Couillette, (Math), Mrs Lisan Yu (Meteorology), Mr David Legler (Meteorology), Mr Zhang (G.F.D.I.)

MEMBERSHIP ON M.SC. COMMITTEES

Major Professor for Maria Hopgood.M.Sc. Thesis in Numerical Optimization.

Thesis entitled **Comparison of Several Limited Memory Quasi-Newton Methods**

Degree awarded July 1990.

Member of Committee of 6 M.Sc. students.

Present PH.D. STUDENTS

Santha Akella

Defended his doctoral Thesis this Spring 2006, April 3, 20006.(Dept of Mathematics).
His thesis title is "Deterministic and Stochastic aspects of Data Assimilation".
Presently postdoctoral Research Associate at the Johns Hopkins University.

Jakir Hossen

Supported By NASA grant.
Defended his Ms thesis in Dept of Scientific Computing.
Relocated to University of Virginia, Charlottesville as R/A .

Xiao Chen

Pursuing a doctoral thesis in Dept of Mathematics with me serving as his Major Professor on the topic of optimal control and model reduction for 2 and 3-D fluid-dynamics models.

Jeff Steward

Pursuing a Ph.D. in the Department of Scientific computing on topics related to reduced order modeling of fluid dynamics and pde constrained optimization

Postdoctoral Fellows

Dr Yanhua Cao

Dr Mohamed Jardak

Past PH.D. STUDENTS

Optimal Control of Flow

Christian Homescu. Thesis defended 2002

Claudia Musat

Graduated with Ms in Applied and Numerical Analysis

Cui Zhenlu Topics in Applied and Numerical Analysis

Ana- Maria Croicu Dis Only:Perfectly matched Layer for Nonlinear Shallow Water Equations (Obtained Ph.D.with Prof M.Y. Hussaini

PH.D. Theses Completed where I served as Major Professor

1. **Zhi Wang, 1993**: Variational Data Assimilation with 2-D Shallow Water Equations and 3-D FSU Global Spectral Models, *Ph. D. Dissertation*, Department of Mathematics, College of Arts and Sciences, The Florida State University, 235 pp.

Presently Senior Software Manage, FEDEXP,Dallas

2.**Yihong Cai**, 1994:Domain Decomposition algorithms and parallel Computation Techniques for the Numerical Solution of PDE's with Applications to the Finite Element Shallow-Water Flow.*Ph. D. Dissertation*, Department of Mathematics, College of Arts and Sciences, The Florida State University,

Presently Senior Software Engineer,Bitstream Corporation,Boston

3.**Yanqiu Zhu, 1998** : 4-D Variational Data Assimilation and parameter Estimation Using the FSU Global Spectral Model and its Full Physics Adjoint *Ph. D. Dissertation*, Department of Geophysical Fluid Dynamics, College of Arts and Sciences, The Florida State University.

Presently Research Scientist at NASA/GSFC/DAO,Greenbelt,MD

4. **Li Jichun,1998**: Finite Element Applications and Analysis for Singularly perturbed Problems and Shallow-Water Equations. *Ph. D. Dissertation*, Department of Mathematics, College of Arts and Sciences, The Florida State University,

Presently Assistant Professor, Department of Mathematical Sciences, University of Nevada, LAS Vegas

5. **Chris Homescu,2002**: Optimal Control of Continuous and Discontinuous Flow. *Ph. D. Dissertation*, Department of Mathematics, College of Arts and Sciences, The Florida State University.

Presently Wachovia Securities-Quantitative Analysis, Interest Rate Derivatives Associate.

Contact: (704)715-8473, CHARLOTTE, NC 28202.e-mail address: cristian.homescu@wachovia.com

6. **Santha Akella, 2006**: Deterministic and Stochastic aspects of Data Assimilation.

MSc. Thesis Completed where I served as Major Professor

Maria Hopgood. M.Sc. Thesis in Numerical Optimization.(1990)

Thesis entitled **Comparison of Several Limited Memory Quasi-Newton Methods**

Claudia Musat,2000: *MATHEMATICAL OPTIMIZATION METHODS FOR LARGE-SCALE CHEMISTRY APPLICATIONS.*

Department of Mathematics, College of Arts and Sciences, The Florida State University.

Presently completed Master of Financial Engineering, Berkeley and is financial consultant of American Securities, Incorporated,Palo-Alto

Research Associates supported by Research Grants where I am P.I.

Dr Yan Yang, Ph.D. in Meteorology at Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing.
Supported by NASA Grant.

Dr Zhijin Li, Ph.D. in Meteorology, Academia Sinica and A. I.P, Beijing, P.R.C.

Presently Senior Researcher at Jet Propulsion Laboratory, Pasadena, CA

Dr Zhuo Liu,Ph.D. in Meteorology, Academia Sinica and A. I.P, Beijing, P.R.C. *Supported by NSF Grant.*

Former Research Associates supported by Research Grants where I was the P.I.

1. Dr Xiaolei Zou (now Professor, Dept of Meteorology, FSU).
2.Dr Yong Li (now Senior Scientist, NASA/GSFC at Data Assimilation Office)
3.Dr. Weiyu Yang (now Research Associate at NCEP/NOAA, Washington).