BIOGRAPHICAL INFORMATION

Personal

Name: THEODORE GORDON SHEPHERD

Date of Birth: August 6, 1958

Place of Birth: Saskatoon, Saskatchewan, Canada

Citizenship: Canadian

Office Address: Department of Meteorology
University of Reading
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Degrees

Honours B.Sc. (with Distinction) in Mathematics and Physics, University of Toronto, June 1979

Ph.D. in Meteorology, Massachusetts Institute of Technology, September 19, 1984

Thesis: *Rossby Waves and Two-Dimensional Turbulence in the Presence of a Large-Scale Zonal Jet* (Ph.D. Dissertation, M.I.T., 393 pp.; Supervisor: Peter B. Rhines)

Employment

Summer Student, CCRN, Canadian Climate Centre, Atmospheric Environment Service, Downsview, Summers of 1978-1980 (Supervisor: George J. Boer)

Postgraduate Research Assistant, Meteorology & Physical Oceanography, M.I.T., 1979-1984 (Supervisors: Jule G. Charney and Peter B. Rhines)

Assessor, Part IB Mathematical Tripos, Faculty of Mathematics, University of Cambridge, 1987

Postdoctoral Research Associate, Applied Mathematics and Theoretical Physics, University of Cambridge, 1984-1988 (Supervisor: Michael E. McIntyre)

Appointed as Associate Member of the Graduate Faculty, University of Toronto, 1988

Appointed as Member of the Graduate Faculty, University of Toronto, 1990

Assistant Professor, Physics, University of Toronto, 1988-1993

Associate Professor, Physics, University of Toronto, 1993-1996

Full Professor, Physics, University of Toronto, 1996-2013 (on unpaid leave 2012-2013)

Associate Chair, Graduate Studies, Physics, University of Toronto, 2005-2010

Grantham Professor of Climate Science, University of Reading, 2012-present

Leader, Climate Research Division, University of Reading, 2015-present

Honours

Research Fellow, St. Catharine's College, University of Cambridge, 1985-1988

E.W.R. Steacie Fellowship (NSERC), 1995-1997

President's Prize, Canadian Meteorological and Oceanographic Society, 1995

IGERT Distinguished Lecturer, Columbia University, 2003

Elected Fellow of the American Meteorological Society, 2005

Elected Fellow of the Canadian Meteorological and Oceanographic Society, 2005

Patterson Medal of the Meteorological Service of Canada, 2005

Elected Fellow of the Royal Society of Canada, 2007

Fellow, Trinity College, University of Toronto, 2008-2012

Elected Fellow of the American Geophysical Union, 2010

Sackler Lecturer, Tel Aviv University, 2011

FDEPS Lecturer, Kyoto University, 2012

Royal Society Wolfson Research Merit Award, 2012-2017

Elected Fellow of the Royal Society, 2016

Significant Responsibilities

Principal Investigator, Canadian MAM, GCC, C-SPARC, and CMAM20 Projects, 1992-2012

Member, SPARC Scientific Steering Group, World Climate Research Programme, 1994-2004

Co-Chair (with T. Peter and subsequently G. Bodeker), SPARC Scientific Steering Group, World Climate Research Programme, 2007-2012

Chapter Lead Author (with A.R. Ravishankara), 1998 WMO/UNEP Scientific Assessment of Ozone Depletion; Chapter 7: Lower Stratospheric Processes

Editor, Journal of the Atmospheric Sciences, 1999-2001

Chief Editor, Journal of the Atmospheric Sciences, 2001-2005

Coordinating Lead Author (with J.A. Pyle), 2005 IPCC/TEAP Special Report on Safeguarding the Ozone Layer and the Global Climate System (SROC); Chapter 1: Ozone and Climate: A Review of Interconnections

Steering Committee, 2006 WMO/UNEP Scientific Assessment of Ozone Depletion

Scientific Review and Advisory Group (with M.K.W. Ko and S. Solomon), 2010 WMO/UNEP Scientific Assessment of Ozone Depletion

Earth Science Advisory Committee, European Space Agency, 2007-2011

Review Editor, IPCC WG1 Fifth Assessment Report; Chapter 11: Near-Term Climate Change: Projections and Predictability

Steering Committee, 2014 WMO/UNEP Scientific Assessment of Ozone Depletion

Committee on Extreme Weather Events and Climate Change Attribution, US National Academy of Sciences, 2015-2016

Chair, Science Review Group, Met Office Hadley Centre, 2017-present

ACADEMIC HISTORY

Research Endeavours

Geophysical Fluid Dynamics; Wave, Mean-Flow Interaction; Large-Scale Turbulence; General Circulation Dynamics; Nonlinear Stability; Stationary-Transient Interaction; Hamiltonian Structure of Fluid Dynamics; Balanced Dynamics; Middle Atmosphere Dynamics; Transport and Mixing; Stratospheric Ozone Depletion; Ozone and Climate; Model-Measurement Comparison; Data Assimilation; Extreme Event Attribution

Research Grants

1988 University of Toronto, Department of Physics	$ 20,000
1988 University of Toronto, Connaught Fund	$ 10,000
1988-89 Atmospheric Environment Service Subvention	$ 8,000
1988-90 Natural Sciences and Engineering Research Council Operating Grant	$ 50,000
1989-90 Atmospheric Environment Service Subvention	$ 12,000
1989-90 Natural Sciences and Engineering Research Council Infrastructure Grant, Atmospheric Physics RJE Facility (Peltier, P.I., with Cho, Drummond, List, Moore and Shepherd)	$ 50,000
1990-92 Natural Sciences and Engineering Research Council Infrastructure Grant, Atmospheric Physics RJE Facility (Peltier, P.I., with Cho, Drummond, List, Moore and Shepherd)	$ 90,000
1990-91 Natural Sciences and Engineering Research Council Equipment Grant, Atmospheric Physics Workstation Server (Peltier, P.I., with Cho, Drummond, List, Moore and Shepherd	$ 143,000
1990-93 Natural Sciences and Engineering Research Council Operating Grant	$ 111,450
1990-91 Atmospheric Environment Service Subvention	$ 25,000
1991-92 Atmospheric Environment Service Subvention	$ 26,960
1992-94 Natural Sciences and Engineering Research Council Infrastructure Grant, Atmospheric Physics RJE Facility (Peltier, P.I., with Cho, Drummond,	

List, Moore and Shepherd)	$ 70,000
1992 Natural Sciences and Engineering Research Council International Scientific Exchange Award (Prof. Mu)	$ 12,800
1992-95 Atmospheric Environment Service Subvention	$ 90,000
1993-96 Natural Sciences and Engineering Research Council Strategic Grant, Modelling of the Middle Atmosphere (Shepherd, P.I., with Blanchet, Derome, Klaassen, Fyfe, Laprise, McConnell and McFarlane)	$ 421,000
1993 Natural Sciences and Engineering Research Council Strategic Equipment Grant, Modelling of the Middle Atmosphere: Graphics Workstations (Shepherd, P.I., with Blanchet, Derome, Klaassen, Laprise and McConnell)	$ 98,378
1993-97 Natural Sciences and Engineering Research Council Operating Grant	$ 152,800
1993-95 Institute of Space and Terrestrial Science Contract, Modelling of the Middle Atmosphere	$ 24,000
1994-96 Natural Sciences and Engineering Research Council Infrastructure Grant, Atmospheric Physics RJE Facility (Peltier, P.I., with Cho, Drummond, List, Moore and Shepherd)	$ 50,000
1994-97 Atmospheric Environment Service Canadian Climate Research Network, Collaborative Research Project, Modelling of the Middle Atmosphere (Shepherd, P.I., with Blanchet, Derome, Fyfe, Klaassen, Laprise, Manson, McConnell, McDade, McFarlane, McLandress and Ward)	$ 1,346,260
1995-97 Natural Sciences and Engineering Research Council Research Grant (Steacie Supplement)	$ 79,000

1995-97 Atmospheric Environment Service Subvention	$ 45,000
1997-2000 Natural Sciences and Engineering Research Council Strategic Project, Modelling of the Middle Atmosphere (Phase 2) (Shepherd, P.I., with Blanchet, Folkins, Fyfe, Klaassen, McConnell, McDade and McFarlane)	$ 904,800
1997-2000 Atmospheric Environment Service Canadian Climate Research Network, Collaborative Research Project, Modelling of the Middle Atmosphere (Phase 2) (Shepherd, P.I., with Blanchet, Folkins, Fyfe, Klaassen, McConnell, McDade and McFarlane)	$ 990,000
1997-2001 Natural Sciences and Engineering Research Council Discovery Grant	$ 216,090
1997-1998 Atmospheric Environment Service Subvention	$ 14,000
1998-2000 Atmospheric Environment Service Subvention	$ 20,000
2000-2001 Atmospheric Environment Service Subvention	$ 20,000
2000-2005 Natural Sciences and Engineering Research Council Strategic Project, Modelling of Global Chemistry for Climate (Shepherd, P.I., with Abbatt, Ariya, Folkins, Lohmann, Li, McConnell, Michelangeli, Scinocca, McFarlane, Polavarapu and Ward)	$ 1,892,750
2000-2003 Meteorological Service of Canada Canadian Climate Research Network Collaborative Research Project, Modelling of Global Chemistry for Climate, (Shepherd, P.I., with Abbatt, Ariya, Folkins, Lohmann, Li, McConnell, Michelangeli, Scinocca, McFarlane, Polavarapu and Ward)	$ 819,300
2000-2001 Canadian Space Agency Operating Contract	

Data Assimilation and Modelling in Relation to Canadian Space-Based Measurements and Design of New Measurement Systems (Shepherd, P.I., with McConnell)	$ 105,808
2001-2007 Canadian Space Agency Contribution Agreement Modelling of Global Chemistry for Climate (Shepherd, P.I., with McConnell)	$ 426,000
2001-2006 Canadian Foundation for Climate and Atmospheric Sciences Research Network Modelling of Global Chemistry for Climate (Shepherd, P.I., with Abbatt, Ariya, Folkins, Lohmann, McConnell, Michelangeli, Scinocca, McFarlane, Polavarapu and Ward)	$ 2,190,555
2001-2005 Natural Sciences and Engineering Research Council Discovery Grant	$ 280,000
2002 Canada Foundation for Innovation PSciNet II Computing Facility (Peltier, P.I., with Ethier, John, Orr, Shepherd, Sinervo, Sipe and Zingg)	$ 5,570,671
2002-2005 Natural Sciences and Engineering Research Council Collaborative Research Opportunities Grant MANTRA 2002/2003 (Strong, P.I., with Bernath, Drummond, Fast, McConnell, McElroy, Quine, Shepherd and Solheim)	$ 510,000
2004-2007 Canadian Space Agency Advanced Studies Contract, MOPITT-2 (Drummond, P.I., with Abbatt, Degenstein, Edwards, Gille, Hackett, McConnell, Michelangeli, Ménard, Shepherd and Strong)	$ 600,000
2004-2007 Canadian Space Agency Facility for Data Assimilation and Modelling based on the CMAM (Shepherd, P.I., with McConnell, Polavarapu and Rochon)	$ 465,000

2004-2005
Environment Canada
Climate Change Action Fund
SPARC International Project Office $ 100,000

2004-2011
Canadian Foundation for Climate and
Atmospheric Sciences Grant
SPARC International Project Office $ 1,051,881

2005-2012
Canadian Space Agency
SPARC International Project Office $ 280,000

2005-2010
Natural Sciences and Engineering Research Council
Discovery Grant $ 318,500

2005-2008
Natural Sciences and Engineering Research Council
Strategic Project, Stratosphere-Troposphere
Dynamical Coupling (Kushner, P.I., with Shepherd
and Scinocca) $ 459,000

2006-2009
Canadian Foundation for Climate and Atmospheric
Sciences Research Grant
Energy and momentum consistency in subgrid-scale
parameterization for climate models
(Shepherd, P.I., with McFarlane) $ 207,000

2006-2011
Canadian Foundation for Climate and Atmospheric
Sciences Research Network
The Canadian SPARC Programme
(Shepherd, P.I., with Bourqui, Folkins, Jones,
Kharin, Kushner, Martin, McConnell, McFarlane,
Melo, Polavarapu, Rochon, Scinocca and Sloan) $ 3,200,000

2006-2009
Natural Sciences and Engineering Research Council
Special Research Opportunity
International Polar Year
(Shepherd, P.I., with McFarlane and Polavarapu) $ 322,000

2007-2009
Canadian Space Agency
Space Science Enhancement Program (Strong, P.I.,

with Bernath, McLinden, Shepherd and Walker)	$ 150,000
2007-2011 Canadian Space Agency The Canadian SPARC Programme	$ 920,000
2008-2010 Canadian Foundation for Climate and Atmospheric Sciences Research Grant Inferring gravity-wave drag from data assimilation (Shepherd, P.I., with Polavarapu)	$ 118,000
2008-2010 Canadian Foundation for Climate and Atmospheric Sciences C-SPARC Network Supplement Grant	$ 200,000
2010-2011 Canadian Foundation for Climate and Atmospheric Sciences Research Grant Impact of climate-induced UV radiation changes on human health (Shepherd, P.I., with McFarlane)	$ 76,600
2010-2013 Canadian Space Agency Space Science Enhancement Program (Strong, P.I., with Shepherd and Walker)	$ 200,000
2010-2013 Canadian Space Agency Space Science Enhancement Program (Walker, P.I., with Shepherd)	$ 200,000
2010-2015 Natural Sciences and Engineering Research Council Discovery Grant	$ 425,000
2010-2011 Canadian Foundation for Climate and Atmospheric Sciences C-SPARC Network Supplement Grant	$ 100,000
2011-2013 Canadian Space Agency CMAM20: A CMAM reanalysis (Shepherd, P.I., with de Grandpré, Fioletov, Jones, Plummer and Scinocca)	$ 829,800
2011-2014 Environment Canada Contribution Agreement	$ 240,000

2012-2014 European Space Agency ESA-SPARC Initiative	€ 50,582
2012-2013 Canadian Space Agency WCRP/SPARC Polar Climate Predictability Initiative (Strong, P.I., with Shepherd)	$ 138,000
2012-2017 Royal Society Wolfson Research Merit Award	£ 75,000
2013-2017 European Union Marie Curie Career Integration Grant	€ 100,000
2014-2020 European Research Council Advanced Grant	€ 2,489,151
2017-2020 Natural Environment Research Council Standard Grant "DOCILE" (Reading P.I.)	£104,035 (Reading share)
2019-2023 European Union Remote Climate Effects and their Impact on European sustainability, Policy and Trade (RECEIPT) (Reading P.I.)	€ 400,000 (Reading share)

SCHOLARLY AND PROFESSIONAL WORK

Refereed Publications

1. Boer, G.J. and Shepherd, T.G., 1983. Large-scale two-dimensional turbulence in the atmosphere. *J. Atmos. Sci.*, **40**, 164-184.

2. Shepherd, T.G., 1983. Mean motions induced by baroclinic instability in a jet. *Geophys. Astrophys. Fluid Dyn.*, **27**, 35-72.

3. Shepherd, T.G., 1985. Time development of small disturbances to plane Couette flow. *J. Atmos. Sci.*, **42**, 1868-1871.

4. Shepherd, T.G., 1987. A spectral view of nonlinear fluxes and stationary-transient interaction in the atmosphere. *J. Atmos. Sci.*, **44**, 1166-1178.

5. Shepherd, T.G., 1987. Inhomogeneous two-dimensional turbulence in the atmosphere. In *Advances in Turbulence* (ed. G. Comte-Bellot and J. Mathieu), pp. 269-278, Springer-Verlag.

6. McIntyre, M.E. and Shepherd, T.G., 1987. An exact local conservation theorem for finite-amplitude disturbances to nonparallel shear flows, with remarks on Hamiltonian structure and on Arnol'd's stability theorems. *J. Fluid Mech.*, **181**, 527-565.

7. Shepherd, T.G., 1987. Rossby waves and two-dimensional turbulence in a large-scale zonal jet. *J. Fluid Mech.*, **183**, 467-509.

8. Shepherd, T.G., 1987. Non-ergodicity of two-dimensional flow on a beta-plane and on the surface of a rotating sphere. *J. Fluid Mech.*, **184**, 289-302.

9. Shepherd, T.G., 1988. On Rossby waves modified by weak sinusoidal shear. *Geophys. Astrophys. Fluid Dyn.*, **40**, 225-237.

10. Shepherd, T.G., 1988. Nonlinear saturation of baroclinic instability. Part I: The two-layer model. *J. Atmos. Sci.*, **45**, 2014-2025.

11. Shepherd, T.G., 1988. Rigorous bounds on the nonlinear saturation of instabilities to parallel shear flows. *J. Fluid Mech.*, **196**, 291-322.

12. Shepherd, T.G., 1988. Remarks concerning "The double cascade as a necessary mechanism for the instability of steady equivalent-barotropic flows". *Il Nuovo Cimento C*, **11**, 439-442.

13. Shepherd, T.G., 1989. Nonlinear saturation of baroclinic instability. Part II: Continuously stratified fluid. *J. Atmos. Sci.*, **46**, 888-907.

14. Haynes, P.H. and Shepherd, T.G., 1989. The importance of surface-pressure changes in the response of the atmosphere to zonally-symmetric thermal and mechanical forcing. *Quart. J. Roy. Meteor. Soc.*, **115**, 1181-1208.

15. Carnevale, G.F. and Shepherd, T.G., 1990. On the interpretation of Andrews' theorem. *Geophys. Astrophys. Fluid Dyn.*, **51**, 1-17.

16. Shepherd, T.G., 1990. A general method for finding extremal states of Hamiltonian dynamical systems, with applications to perfect fluids. *J. Fluid Mech.*, **213**, 573-587.

17. Shepherd, T.G., 1990. Isovortical constraints on the statistical-dynamical behaviour of strongly nonlinear two-dimensional and quasi-geostrophic flow. In *Topological Fluid Mechanics* (ed. H.K. Moffatt and A. Tsinober), pp. 278-287, Cambridge University Press.

18. Shepherd, T.G., 1990. Symmetries, conservation laws, and Hamiltonian structure in geophysical fluid dynamics. *Adv. Geophys.*, **32**, 287-338.

19. Haynes, P.H., Marks, C.J., McIntyre, M.E., Shepherd, T.G. and Shine, K.P., 1991. On the "downward control" of extratropical diabatic circulations by eddy-induced mean zonal forces. *J. Atmos. Sci.*, **48**, 651-678.

20. Shepherd, T.G., 1991. Nonlinear stability and the saturation of instabilities to axisymmetric vortices. *Eur. J. Mech. B.*, **10**, No. 2 - Suppl., 93-98.

21. Dritschel, D.G., Haynes, P.H., Juckes, M.N. and Shepherd, T.G., 1991. The stability of a two-dimensional vorticity filament under uniform strain. *J. Fluid Mech.*, **230**, 647-665.

22. Scinocca, J.F. and Shepherd, T.G., 1992. Nonlinear wave-activity conservation laws and Hamiltonian structure for the two-dimensional anelastic equations. *J. Atmos. Sci.*, **49**, 3-25.

23. Shepherd, T.G., 1992. Arnol'd stability applied to fluid flow: successes and failures. In *Nonlinear Phenomena in Atmospheric and Oceanic Sciences* (ed. G.F. Carnevale and R.T. Pierrehumbert), pp. 187-206, Springer-Verlag.

24. Shepherd, T.G., 1992. Extremal properties and Hamiltonian structure of the Euler equations. In *Topological Aspects of the Dynamics of Fluids and Plasmas* (ed. H.K. Moffatt et al.), pp. 275-292, Kluwer Academic.

25. Cho, H.-R., Shepherd, T.G. and Vladimirov, V.A., 1993. Application of the direct Liapunov method to the problem of symmetric stability in the atmosphere. *J. Atmos. Sci.*, **50**, 822-836.

26. Shepherd, T.G., 1993. A unified theory of available potential energy. *Atmos.-Ocean*, **31**, 1-26.

27. Shepherd, T.G., 1993. Nonlinear saturation of baroclinic instability. Part III: Bounds on the energy. *J. Atmos. Sci.*, **50**, 2697-2709.

28. Mu Mu and Shepherd, T.G., 1994. On Arnol'd's second nonlinear stability theorem for two-dimensional quasi-geostrophic flow. *Geophys. Astrophys. Fluid Dyn.*, **75**, 21-37.

29. Mu Mu, Zeng Qingcun, Shepherd, T.G. and Liu Yongming, 1994. Nonlinear stability of multilayer quasi-geostrophic flow. *J. Fluid Mech.*, **264**, 165-184.

30. Douglas, S.C., Harrison, D.M. and Shepherd, T.G., 1994. The physical pendulum in an advanced undergraduate course in mechanics. *Computers in Physics*, **8**, 416-419.

31. Mu Mu and Shepherd, T.G., 1994. Nonlinear stability of Eady's model. *J. Atmos. Sci.*, **51**, 3427-3436.

32. Warn, T., Bokhove, O., Shepherd, T.G. and Vallis, G.K., 1995. Rossby-number expansions, slaving principles, and balance dynamics. *Quart. J. Roy. Meteor. Soc.*, **121**, 723-739.

33. Shepherd, T.G., 1995. The Canadian MAM project. *CMOS Bulletin*, **23**, 3-12.

34. Kushner, P.J. and Shepherd, T.G., 1995. Wave-activity conservation laws and stability theorems for semi-geostrophic dynamics. Part I: Pseudomomentum-based theory. *J. Fluid Mech*., **290**, 67-104.

35. Kushner, P.J. and Shepherd, T.G., 1995. Wave-activity conservation laws and stability theorems for semi-geostrophic dynamics. Part II: Pseudoenergy-based theory. *J. Fluid Mech*., **290**, 105-129.

36. Bowman, J.C. and Shepherd, T.G., 1995. Nonlinear symmetric stability of planetary atmospheres. *J. Fluid Mech*., **296**, 391-407.

37. Bokhove, O. and Shepherd, T.G., 1996. On Hamiltonian balanced dynamics and the slowest invariant manifold. *J. Atmos. Sci.*, **53**, 276-297.

38. Haynes, P.H., McIntyre, M.E. and Shepherd, T.G., 1996. Reply to Comment of J. Egger. *J. Atmos. Sci.*, **53**, 2105-2107.

39. Mu Mu, Shepherd, T.G. and Swanson, K., 1996. On nonlinear symmetric stability and the nonlinear saturation of symmetric instability. *J. Atmos. Sci.*, **53,** 2918-2923.

40. Shepherd, T.G., Semeniuk, K. and Koshyk, J.N., 1996. Sponge-layer feedbacks in middle atmosphere models. *J. Geophys. Res.*, **101,** 23447-23464.

41. Liu Yongming, Mu Mu and Shepherd, T.G., 1996. Nonlinear stability of continuously stratified quasi-geostrophic flow. *J. Fluid Mech.*, **325,** 419-439.

42. Ngan, K. and Shepherd, T.G., 1997. Chaotic mixing and transport in Rossby-wave critical layers. *J. Fluid Mech.*, **334,** 315-351.

43. Nore, C. and Shepherd, T.G., 1997. A Hamiltonian weak-wave model for shallow-water flow. *Proc. R. Soc. A*, **453**, 563-580.

44. Ren, S. and Shepherd, T.G., 1997. Lateral boundary contributions to wave-activity invariants and nonlinear stability theorems for balanced dynamics. *J. Fluid Mech.*, **345**, 287-305.

45. Beagley, S.R., de Grandpré, J., Koshyk, J.N., McFarlane, N.A. and Shepherd, T.G., 1997. Radiative-dynamical climatology of the first-generation Canadian Middle Atmosphere Model. *Atmos.-Ocean*, **35**, 293-331.

46. Ngan, K. and Shepherd, T.G., 1997. Comments on some recent measurements of anomalously steep N_2O and O_3 tracer spectra in the stratospheric surf zone. *J. Geophys. Res.*, **102**, 24001-24004.

47. Kushner, P.J., McIntyre, M.E. and Shepherd, T.G., 1998. Coupled Kelvin-wave and

mirage-wave instabilities in semi-geostrophic dynamics. *J. Phys. Oc.*, **28**, 513-518.

48. Vanneste, J. and Shepherd, T.G., 1998. On the group-velocity property for wave-activity conservation laws. *J. Atmos. Sci.*, **55**, 1063-1068.

49. Vanneste, J. and Shepherd, T.G., 1999. On wave action and phase in the non-canonical Hamiltonian formulation. *Proc. R. Soc. A*, **455**, 3-21.

50. Ravishankara, A.R. & Shepherd, T.G. (Lead Authors) 1999 *Lower Stratospheric Processes*. Chapter 7 of *Scientific Assessment of Ozone Depletion: 1998*, World Meteorological Organization, 76 pp.

51. Wirosoetisno, D. and Shepherd, T.G., 1999. Nonlinear stability of Euler flows in two-dimensional periodic domains. *Geophys. Astrophys. Fluid Dyn.*, **90**, 229-246.

52. Ngan, K. and Shepherd, T.G., 1999. A closer look at chaotic advection in the stratosphere. Part I. Geometric structure. *J. Atmos. Sci.*, **56**, 4134-4152.

53. Ngan, K. and Shepherd, T.G., 1999. A closer look at chaotic advection in the stratosphere. Part II. Statistical diagnostics. *J. Atmos. Sci.*, **56**, 4153-4166.

54. Shepherd, T.G., 1999. The stratosphere and climate. *CMOS Bulletin*, **27**, 174-179.

55. Pawson, S., Kodera, K., Hamilton, K., Shepherd, T.G., and 36 others, 2000. The GCM-Reality Intercomparison Project for SPARC (GRIPS): Scientific issues and initial results. *Bull. Amer. Met. Soc.*, **81**, 781-796.

56. Wirosoetisno, D. and Shepherd, T.G., 2000. On the existence of two-dimensional Euler flows satisfying energy-Casimir stability criteria. *Phys. Fluids*, **12**, 727-730.

57. Wirosoetisno, D. and Shepherd, T.G., 2000. Averaging, slaving and balance dynamics in a simple atmospheric model. *Physica D*, **141**, 37-53.

58. Shepherd, T.G., Koshyk, J.N. and Ngan, K., 2000. On the nature of large-scale mixing in the stratosphere and mesosphere. *J. Geophys. Res.*, **105**, 12433-12446.

59. Shepherd, T.G., 2000. The middle atmosphere. *J. Atmos. Solar-Terres. Phys.*, **62**, 1587-1601. (Invited review paper for Golden Jubilee issue.)

60. de Grandpré, J., Beagley, S.R., Fomichev, V.I., Griffioen, E., McConnell, J.C., Medvedev, A.S. and Shepherd, T.G., 2000. Ozone climatology using interactive chemistry: Results from the Canadian Middle Atmosphere Model. *J. Geophys. Res.*, **105**, 26475-26491.

61. Iwayama, T., Watanabe, T. and Shepherd, T.G., 2001. Infrared dynamics of decaying two-dimensional turbulence governed by the Charney-Hasegawa-Mima equation. *J. Phys. Soc. Japan*, **70**, 376-386.

62. Semeniuk, K. and Shepherd, T.G., 2001. The middle-atmosphere Hadley circulation and equatorial inertial adjustment. *J. Atmos. Sci.*, **58**, 3077-3096.

63. Semeniuk, K. and Shepherd, T.G., 2001. Mechanisms for tropical upwelling in the stratosphere. *J. Atmos. Sci.*, **58**, 3097-3115.

64. Semeniuk, K. and Shepherd, T.G., 2002. The effect of non-uniform radiative damping on the zonal-mean dynamics of the extratropical middle atmosphere. *Quart. J. Roy. Meteor. Soc.*, **128**, 259-284.

65. Saujani, S. and Shepherd, T.G., 2002. Comments on "Balance and the slow quasimanifold: some explicit results". *J. Atmos. Sci.*, **59**, 2874-2877.

66. Iwayama, T., Shepherd, T.G. and Watanabe, T., 2002. An "ideal" form of two dimensional turbulence. *J. Fluid Mech.*, **456**, 183-198.

67. Fomichev, V.I., Ward, W.E., Beagley, S.R., McLandress, C., McConnell, J.C., McFarlane, N.A. and Shepherd, T.G., 2002. The extended Canadian Middle Atmosphere Model: Zonal-mean climatology and physical parameterizations. *J. Geophys. Res.*, **107**, 4087, 10.1029/2001JD000479.

68. Shepherd, T.G., 2002. Issues in stratosphere-troposphere coupling. *J. Meteor. Soc. Japan*, **80**, 769-792.

69. Iwayama, T., Shepherd, T.G. and Watanabe, T., 2002. Self-similarity of decaying two-dimensional turbulence governed by the Charney-Hasegawa-Mima equation. In *Statistical Theories and Computational Approaches to Turbulence: Modern Perspectives and Application to Global-Scale Flows* (ed. Y. Kaneda and T. Gotoh), pp. 341-349, Springer-Verlag.

70. Tran, C.V., Shepherd, T.G. and Cho, H.-R., 2002. Stability of stationary solutions of the forced Navier-Stokes equations on the two-torus. *Discrete Cont. Dyn. Systems B*, **2,** 483-494**.**

71. Tran, C.V. and Shepherd, T.G., 2002. Constraints on the spectral distribution of energy and enstrophy dissipation in forced two-dimensional turbulence. *Physica D*, **165**, 199-212.

72. Wirosoetisno, D., Shepherd, T.G. and Temam, R., 2002. Free gravity waves and balanced dynamics. *J. Atmos. Sci.*, **59**, 3382-3398.

73. Shepherd, T.G., 2003. Hamiltonian dynamics. In *Encyclopedia of Atmospheric Sciences* (ed. J.R. Holton et al.), pp. 929-938, Academic Press.

74. Austin, J., Shindell, D., Beagley, S.R., Brühl, C., Dameris, M., Manzini, E., Nagashima, T., Newman, P., Pawson, S., Pitari, G., Rozanov, E., Schnadt, C. and Shepherd, T.G., 2003. Uncertainties and assessments of chemistry-climate models of the stratosphere. *Atmos. Chem. Phys.*, **3**, 1-27.

75. Shepherd, T.G., 2003. Ripa's theorem and its relatives. In *Nonlinear Processes in Geophysical Fluid Dynamics* (ed. O. Velasco Fuentes et al.), pp. 1-14, Kluwer Academic.

76. Pendlebury, D. and Shepherd, T.G., 2003. Planetary-wave-induced transport in the stratosphere. *J. Atmos. Sci.*, **60**, 1456-1470.

77. Sankey, D. and Shepherd, T.G., 2003. Correlations of long-lived chemical species in a middle atmosphere general circulation model. *J. Geophys. Res.*, **108**, 4494, 10.1029/ 2002JD002799.

78. Fioletov, V.E. and Shepherd, T.G., 2003. Seasonal persistence of midlatitude total ozone anomalies. *Geophys. Res. Lett.*, **30**, 1417, 10.1029/2002GL016739.

79. Codoban, S. and Shepherd, T.G., 2003. Energetics of a symmetric circulation including momentum constraints. *J. Atmos. Sci.*, **60**, 2019-2028.

80. Shepherd, T.G., 2003. Large-scale atmospheric dynamics for atmospheric chemists. *Chem. Reviews*, **103**, 4509-4531.

81. Tran, C.V., Shepherd, T.G. and Cho, H.-R., 2004. Extensivity of two-dimensional turbulence. *Physica D*, **192**, 187-195.

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199. National Academies of Sciences, Engineering, and Medicine, 2016: Attribution of Extreme Weather Events in the Context of Climate Change. Washington, DC: National Academies Press. DOI: 10.17226/21852 (on author team of 10)

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203. Zappa, G. and Shepherd, T.G., 2017. Storylines of atmospheric circulation change for European regional climate impact assessment. *J. Clim.*, **30**, 6561–6577.

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207. Maraun, D., Shepherd, T.G., Widmann, M., Zappa, G., Walton, D., Gutierrez, J.M., Hagemann, S., Richter, I., Soares, P.M.M., Hall, A. and Mearns, L.O., 2017. Towards process-informed bias correction of climate change simulations. *Nature Clim. Change*, **7**, 764–773.

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213. Boljka, L., Shepherd, T.G. and Blackburn, M., 2018. On the coupling between barotropic and baroclinic modes of extratropical atmospheric variability. *J. Atmos. Sci*., **75**, 1853–1871.

214. Polichtchouk, I., Shepherd, T.G. and Byrne, N.J., 2018. Impact of parametrized nonorographic gravity wave drag on stratosphere-troposphere coupling in the Northern and Southern Hemispheres. *Geophys. Res. Lett*., **45**, 8612–8618, doi:10.1002/2018GL078981.

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216. Tamarin-Brodsky, T., Hodges, K., Hoskins, B.J. and Shepherd, T.G., 2019. A dynamical perspective on atmospheric temperature variability and its response to climate change. *J. Clim*., **32**, 1707–1724.

217. Sandu, I., van Niekerk, A., Shepherd, T.G., Vosper, S., Zadra, A., Bacmeister, J., Beljaars, A., Brown, A., Dörnbrack, A., McFarlane, N., Pithan, F. and Svensson, G., 2019. Impacts of orography on large-scale atmospheric circulation. *npj Clim. Atmos. Sci*., **2**:10, doi: 10.1038/s41612-019-0065-9.

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219. Shepherd, T.G., 2019. Storyline approach to the construction of regional climate change information. *Proc. R. Soc. A*, **475**, 20190013, doi:10.1098/rspa.2019.0013.

220. Ceppi, P. and Shepherd, T.G., 2019. The role of the stratospheric polar vortex for the austral jet response to greenhouse gas forcing. *Geophys. Res. Lett*., **46**, 6972–6979.

221. Byrne, N.J., Shepherd, T.G. and Polichtchouk, I., 2019. Subseasonal-to-seasonal predictability of the Southern Hemisphere eddy-driven jet during austral spring and early summer. *J. Geophys. Res*., **124**, 6841–6855.

222. Leung, T.Y., Leutbecher, M., Reich, S. and Shepherd, T.G., 2019. Atmospheric predictability: revisiting the inherent finite-time barrier. *J. Atmos. Sci*., in press.

223. Boljka, L. and Shepherd, T.G., 2019. Multiscale extratropical barotropic variability on the subseasonal-to-seasonal timescale. *Quart. J. Roy. Meteor. Soc*., in press.

224. Hartung, K., Shepherd, T.G., Hoskins, B.J., Methven, J. and Svensson, G., 2019. Diagnosing topographic forcing in an atmospheric dataset: the case of the North American Cordillera. *Quart. J. Roy. Meteor. Soc*., in press.

225. Saggioro, E. and Shepherd, T.G., 2019. Quantifying the timescale and strength of Southern Hemisphere intra-seasonal stratosphere-troposphere coupling. *Geophys. Res. Lett*., in revision.

Non-Refereed Publications

1. Shepherd, T.G., 1988. Nonlinear stability and some of its implications. 1987 GFD Summer School, Woods Hole Oceanographic Institution Technical Report WHOI-88-16, pp. 139-143.

2. Shepherd, T.G., 1991. Wave activity and the general circulation of the atmosphere. Preprint volume, American Meteorological Society 8th Conference on Atmospheric and Oceanic Waves and Stability, pp. 143-146.

3. Shepherd, T.G., 1993. On the maintenance of the westerlies. 1992 GFD Summer School, Woods Hole Oceanographic Institution Technical Report WHOI-93-24, pp. 186-189.

4. Shepherd, T.G., 1993. A unified theory of available potential energy. Preprint volume, American Meteorological Society 9th Conference on Atmospheric and Oceanic Waves and Stability, pp. 406-409.

5. Shepherd, T.G., 1994. Applications of Hamiltonian theory to GFD. 1993 GFD Summer School, Woods Hole Oceanographic Institution Technical Report WHOI-94-12, pp. 113-152.

6. Shepherd, T.G., 1994. Scaling of saturation amplitudes in baroclinic instability. Proceedings of the 17th Stanstead Seminar, *The Role of Large-Scale, Extratropical Dynamics in Climate Change* (ed. T.G. Shepherd), McGill University Technical Report, pp. 169-176.

7. Shepherd, T.G., 1997. Transport and mixing in the lowermost stratosphere. Proceedings of the 1st SPARC General Assembly, World Climate Research Programme Technical Report WCRP-99, WMO/TD No. 814, pp. 351-354.

8. Shepherd, T.G., 1997. Transport and mixing in the lower stratosphere: a review of recent developments. *SPARC Newsletter*, No. 9, pp. 15-19.

9. Shepherd, T.G., 1997. The influence of dynamical processes on ozone abundance. Chapter 2 of *Ozone Science: A Canadian Perspective on the Changing Ozone Layer* (ed. D.I. Wardle et al.), pp. 41-56. Environment Canada.

10. Shepherd, T.G., 1998. Dynamics and transport in the upper troposphere and lower stratosphere. Chapter 3.2 of SPARC Implementation Plan. World Climate Research Programme Technical Report, 105, WMO/TD-No. 914, pp. 63-74.

11. Shepherd, T.G., Koshyk, J.N. and Ngan, K., 1999. Where in the middle atmosphere is chaotic advection relevant? Preprint volume, American Meteorological Society 12th Conference on Atmospheric and Oceanic Fluid Dynamics, pp. 320-323.

12. Shepherd, T.G., 2000. On the role of the stratosphere in the climate system. *SPARC Newsletter*, No. 14. pp. 7-10.

13. Haynes, P.H. and Shepherd, T.G., 2001. Report on the SPARC Tropopause Workshop. *SPARC Newsletter*, No. 17, pp. 3-10.

14. Shepherd, T.G., 2004. Issues for stratospheric modelling and assimilation. Proceedings of the ECMWF/SPARC Workshop on Modelling and Assimilation for the Stratosphere and Troposphere, pp. 29-35.

15. Eyring, V., Harris, N.R.P., Rex, M., Shepherd, T.G. and others, 2004. Comprehensive summary of the workshop on Process-oriented validation of coupled chemistry-climate models. *SPARC Newsletter*, No. 23, pp. 5-11.

16. Shepherd, T.G., 2005. Hamiltonian geophysical fluid dynamics. Applications of Advanced Mathematical and Computational Methods to Atmospheric and Oceanic Problems (MCAO 2003), National Center for Atmospheric Research, pp. 63-90.

17. Shepherd, T.G., Plumb, R.A. and Wofsy, S.C., 2005. Preface to JAS Special Issue on the Antarctic Stratospheric Sudden Warming and Split Ozone Hole of 2002. *J. Atmos. Sci.*, **62**, 565-566.

18. Eyring, V., Kinnison, D.E. and Shepherd, T.G., 2005. Overview of planned coupled chemistry-climate simulations to support upcoming ozone and climate assessments. *SPARC Newsletter*, No. 25, pp. 11-17.

19. Polavarapu, S. and Shepherd, T.G., 2006. Report on the Joint SPARC Workshop on Data Assimilation and Stratospheric Winds. *SPARC Newsletter*, No. 26, pp. 20-27.

20. Polavarapu, S., Eskes, H. and Shepherd, T.G., 2007. Report on the SPARC Data Assimilation Workshop. *SPARC Newsletter*, No. 28, pp. 12-19.

21. Baldwin, M.P., Dameris, M. and Shepherd, T.G., 2007. How will the stratosphere affect climate change? *Science*, **316**, 1576-1577.

22. Shepherd, T.G. and Randel, W.J., 2007. Key issues arising from the 2006 WMO/UNEP

Ozone Assessment. *SPARC Newsletter*, No. 29, pp. 20-22.

23. Shaw, T.A. and Shepherd, T.G., 2008. Raising the roof. *Nature Geoscience*, **1**, 12-13.

24. Shepherd, T.G, Arblaster, J.M., Bitz, C.M., Furevik, T., Goosse, H., Kattsov, V.M., Marshall, J., Ryabinin, V. and Walsh, J.E., 2011. Report on WCRP Workshop on Seasonal to Multi-Decadal Predictability of Polar Climate. *SPARC Newsletter*, **36**, 11–19.

25. Shepherd, T.G., 2011. Mechanisms for predictability of polar climate. *Eos*, **92**, 92.

26. Shepherd, T.G., 2015. Dynamics of temperature extremes. *Nature*, **522**, 425–427.

27. Shepherd, T.G., 2016. Effects of a warming Arctic. *Science*, **353**, 989–990.

28. Shepherd, T.G., 2017. The general circulation of the atmosphere and oceans. Chapter 1 of *Mathematics of Planet Earth: A Primer* (D. Crisan, ed.), World Scientific, 372 pp.

29. Karlsson, B. and Shepherd, T.G., 2018. The improbable clouds at the edge of the atmosphere. *Physics Today*, **71**(6), 30–36, doi: 10.1063/PT.3.3946.

30. Shepherd, T.G., 2018. Extreme weather events. In McGraw Hill Encyclopedia of Science & Technology, McGraw Hill Education, doi: 10.1036/1097-8542.249370.

31. Shepherd, T.G., Polichtchouk, I., Hogan, R.J. and Simmons, A.J., 2018. Report on the Stratosphere Task Force. Technical Memorandum 824, 32 pp., European Centre for Medium-Range Weather Forecasts, http://www.ecmwf.int/en/research/publications.

32. Sutton, R., Hoskins, B., Palmer, T., Shepherd, T. and Slingo, J., 2018. Tighten attribution of weather events. *Nature*, **561**, 177.

Papers Delivered at Scientific Meetings

(Papers given by students, post-docs or other collaborators for which I am a co-author are not included)

1. "A barotropic study of waves and turbulence in a stationary zonal jet", Canadian Meteorological and Oceanographic Society 18th Annual Congress, Halifax, Nova Scotia, 29 May - 1 June, 1984.

2. "Rossby waves and two-dimensional turbulence in a large-scale zonal jet", 1st European Turbulence Conference, Lyon, France, 1-4 July, 1986.

3. "A spectral determination of the nature and extent of stationary-transient interaction in the atmosphere", Royal and American Meteorological Societies' Conference on the Variability of the Atmosphere and Oceans on Timescales of a Month to Several Years, London, England, 8-12 September, 1986.

4. "Nonlinear stability of two-dimensional steady flows", American Meteorological Society 6th Conference on Atmospheric and Oceanic Waves and Stability, Seattle, Washington,

25-28 August, 1987.

5. "Non-ergodicity and other implications of finite-amplitude stability theorems", European Geophysical Society 13th General Assembly, Bologna, Italy, 21-25 March, 1988.

6. "A method for deriving rigorous bounds on the nonlinear saturation of instabilities to inviscid parallel shear flows", 30th British Theoretical Mechanics Colloquium, London, England, 11-15 April, 1988.

7. "A new twist to the classical axisymmetric-vortex response problem: implications for eddy forcing of the zonal mean flow", American Meteorological Society 7th Conference on Atmospheric and Oceanic Waves and Stability, San Francisco, California, 10-14 April, 1989.

8. "The importance of surface-pressure changes in the response of the atmosphere to zonally-symmetric thermal and mechanical forcing", 5th Scientific Assembly of the International Association of Meteorology and Atmospheric Physics, Reading, England, 31 July - 12 August, 1989.

9. "Isovortical constraints on the statistical-dynamical behaviour of strongly nonlinear two-dimensional and quasi-geostrophic flows", IUTAM Symposium on Topological Fluid Mechanics, Cambridge, England, 13-18 August 1989.

10. "The Hamiltonian structure of geophysical fluid dynamics", Canadian Meteorological and Oceanographic Society 24th Annual Congress, Victoria, B.C., 28 May - 1 June, 1990.

11. "Some aspects of eddy-induced mean meridional circulations in the atmosphere", Canadian Meteorological and Oceanographic Society 24th Annual Congress, Victoria, B.C., 28 May - 1 June, 1990.

12. (Invited talk) "Arnol'd stability applied to fluid flow: successes and failures", Workshop on Nonlinear Phenomena in Atmospheric and Oceanic Sciences, Institute for Mathematics and its Applications, University of Minnesota, 4-8 June, 1990.

13. (Invited talk) "Arnol'd stability applied to fluid flow: successes and failures", 9th Canadian Symposium on Fluid Dynamics, London, Ontario, 11-13 June, 1990.

14. "Nonlinear stability and the saturation of hydrodynamic instabilities", IUTAM Symposium on Nonlinear Stability and Transition to Turbulence, Nice, France, 3-7 September, 1990.

15. "Wave activity and the general circulation of the atmosphere", American Meteorological Society 8th Conference on Atmospheric and Oceanic Waves and Stability, Denver, Colorado, 14-18 October, 1991.

16. (Invited talk) "Extremal properties and Hamiltonian structure of the Euler equations", NATO Advanced Research Workshop on Topological Fluid Mechanics, Institute for

Theoretical Physics, Santa Barbara, California, 1-5 November, 1991.

17. "Two variations on a theme by Rayleigh", Canadian Meteorological and Oceanographic Society 26th Annual Congress, Quebec City, Quebec, 8-12 June, 1992.

18. "Nonlinear symmetric stability", Canadian Meteorological and Oceanographic Society 26th Annual Congress, Quebec City, Quebec, 8-12 June, 1992.

19. "A unified theory of available potential energy", American Meteorological Society 9th Conference on Atmospheric and Oceanic Waves and Stability, San Antonio, Texas, 10-14 May, 1993.

20. "Scaling of saturation amplitudes in baroclinic instability", 17th Stanstead Seminar, Lennoxville, Quebec, 14-18 June, 1993.

21. (Invited talk) "Development of middle atmosphere modelling in Canada", Division of Aeronomy and Space Physics, Canadian Association of Physicists, Winter Workshop, North York, Ontario, 21-22 February, 1994.

22. "A Hamiltonian weak-wave model for shallow-water flow", Canadian Meteorological and Oceanographic Society 28th Annual Congress, Ottawa, Ontario, 30 May-3 June, 1994.

23. "Rossby-number expansions, slaving principles, and balance dynamics", Conference on New Asymptotic Methods in Geophysical Flows, Isaac Newton Institute for Mathematical Sciences, Cambridge, England, 14-16 December, 1994.

24. (Invited talk) "Stratosphere-troposphere exchange", International Union of Geodesy and Geophysics 21st General Assembly, Boulder, Colorado, 2-14 July, 1995.

25. (Invited talk) "Hamiltonian structure and fast and slow degrees of freedom in geophysical fluid dynamics", Workshop on New Directions in Geophysical Fluid Dynamics and Turbulence, Arizona State University, 16-19 May, 1996.

26. (Invited talk) "Issues in middle atmosphere modelling", Canadian Meteorological and Oceanographic Society 30th Annual Congress, Toronto, Ontario, 27-30 May, 1996.

27. (Invited talk) "Hamiltonian structure, symmetry-based metatheory, and fast and slow degrees of freedom in geophysical fluid dynamics: recent advances and future challenges", Research Programme on Mathematics of Atmosphere and Ocean Dynamics, Isaac Newton Institute for Mathematical Sciences, Cambridge, England, July-December, 1996.

28. "A Hamiltonian weak-wave model for shallow-water flow", Workshop on Low-order Models and Balanced Dynamics, Isaac Newton Institute for Mathematical Sciences, Cambridge, England, 21-25 October, 1996.

29. (Invited talk) “Transport and mixing in the lowermost stratosphere”, 1st SPARC General Assembly, Melbourne, Australia, 2-6 December, 1996.

30. “Sponge-layer feedbacks in middle atmosphere models”, 1st SPARC General Assembly, Melbourne, Australia, 2-6 December, 1996.

31. (Invited talk) “SPARC in Canada”, Research of Relevance: Canadian Global Change Program Symposium, Toronto, Ontario, 17-18 March, 1997.

32. (Invited talk) “Hamiltonian structure and fast and slow degrees of freedom in geophysical fluid dynamics”, Canadian Applied Mathematics Society 18th Annual Meeting, Toronto, Ontario, 30 May - 1 June, 1997.

33. “Applications of Arnold stability to atmospheric physics”, Workshop on Applications of Arnold Stability, Fields Institute, University of Toronto, 13-14 June, 1997.

34. “Experiences with a middle atmosphere GCM”, American Meteorological Society 10th Conference on the Middle Atmosphere, Tacoma, Washington, 23-27 June, 1997.

35. “On lateral boundary conditions for balanced models”, American Meteorological Society 11th Conference on Atmospheric and Oceanic Fluid Dynamics, Tacoma, Washington, 23-27 June, 1997.

36. (Invited talk) “The nature of dynamics and transport in the middle atmosphere”, Workshop on the Middle Atmosphere Initiative, Canadian Space Agency, St-Hubert, Québec, 5 March, 1998.

37. (Invited talk) “Hamiltonian structure and fast and slow degrees of freedom in geophysical fluid dynamics”, Conference on Mathematical Problems in Meteorology and Oceanography, ISC, Indiana University, 9-12 November, 1998.

38. “Where in the middle atmosphere is chaotic advection relevant?”, American Meteorological Society 12th Conference on Atmospheric and Oceanic Fluid Dynamics, New York City, 7-11 June, 1999.

    (Invited talk) Discussion leader on stratospheric chemistry and transport, 1999 Gordon Research Conference on Atmosphere Chemistry, Newport, R.I., 14-17 June, 1999 (invitation declined).

39. (Invited talk) “Coupled chemical-dynamical modelling of the middle atmosphere”, International Union of Geodesy and Geophysics 22nd General Assembly, Birmingham, U.K., 19-30 July, 1999.

40. “Where in the middle atmosphere is chaotic advection relevant?”, International Union of Geodesy and Geophysics 22nd General Assembly, Birmingham, U.K., 19-30 July, 1999.

    (Invited talk) Middle atmosphere variability, Fall 1999 Meeting of the American

Geophysical Union, San Francisco (invitation declined).

(Invited talk) GCM modelling of the Brewer-Dobson circulation, Brewer-Dobson Workshop, Oxford University, December 13-15, 1999 (invitation declined).

41. "More experiences with a middle atmosphere GCM", American Meteorological Society 11th Conference on the Middle Atmosphere, Long Beach, CA, 10-13 January, 2000.

42. "On the nature of large-scale mixing in the stratosphere and mesosphere", Division of Atmospheric and Space Physics, Canadian Association of Physicists, Winter Workshop, Toronto, Ontario, 17-18 February, 2000.

43. (Invited talk) "Hamiltonian models of balanced dynamics and wave-vortex interactions", European Geophysical Society 25th General Assembly, Nice, France, 25-29 April, 2000.

44. "Where in the world is chaotic advection relevant?" European Geophysical Society 25th General Assembly, Nice, France, 25-29 April, 2000.

45. (Invited talk) "Middle atmosphere modelling from the ground up", PSMOS Workshop 2000, Toronto, Ontario, 23-26 May, 2000.

46. "A fine balance: constraints on vortical/gravity-wave interactions", Canadian Meteorological and Oceanographic Society 34th Annual Congress, Victoria, B.C., 29 May - 2 June, 2000.

47. "Shaken, or stirred? Transport and mixing in the atmosphere", Canadian Meteorological and Oceanographic Society 34th Annual Congress, Victoria, B.C., 29 May - 2 June, 2000.

48. (Invited talk) "Shaken, or stirred? Mixing in the middle atmosphere", Workshop on Mixing in the Atmosphere and Ocean, Courant Institute of Mathematical Sciences, New York, 8-9 December, 2000.

49. (Invited talk) "Issues in stratosphere-troposphere coupling", Japan-US seminar on coupling of the troposphere and stratosphere by dynamical, radiative and chemical processes, Kyoto University, 13-17 March, 2001.

50. (Invited talk) "Capabilities of the Canadian Middle Atmosphere Model", GCOM-A1 Workshop, York University, March 29-30, 2001.

(Invited talk) Minisymposium on mixing and transport in geophysical flows, SIAM Dynamical Systems Meeting, Snowbird, Utah, May 20-24, 2001 (invitation declined).

(Invited talk) Spring 2001 Meeting of the American Geophysical Union, Boston (invitation declined).

(Invited talk) Canadian Applied and Industrial Mathematics Society, Victoria, B.C., June 7-9, 2001 (invitation declined).

51. (Invited plenary talk) "Wave-vortex interactions and implications for mixing in the middle atmosphere", Wave Phenomena III, Edmonton, Alberta, June 11-15, 2001.

(Invited talk) Session on middle atmosphere dynamics, International Association for Meteorology and Atmospheric Sciences, Innsbruck, Austria, July 10-18, 2001 (invitation declined).

(Invited talk) US National Academy of Sciences Frontiers of Science Symposium, Irvine, CA, November 8-10, 2001 (invitation declined).

52. (Invited talk) "Transport processes in the UTLS", UK NERC UTLS Ozone Workshop, Cambridge, U.K., December 17-19, 2001.

(Invited talk) Workshop on Reduced Descriptions of Coupled GFD Systems, Institute for Mathematics and its Applications, University of Minnesota, February 11-15, 2002 (invitation declined).

(Invited talk) Spring 2002 Meeting of the American Geophysical Union, Washington, D.C. (invitation declined).

53. (Invited talk) "Earth system science", 4th Canadian Space Agency Atmospheric Environment Workshop, University of Western Ontario, May 15-17, 2002.

(Invited talk) Workshop on Mathematical Theory and Modelling in Atmosphere-Ocean Science, Mathematisches Forschungsinstitut Oberwolfach, Germany, August 18-24, 2002 (invitation declined).

54. (Invited talk) "Ripa's theorem and its relatives", Pedro Ripa Memorial Colloquium (Nonlinear Processes in Geophysics), Ensenada, Mexico, October 3-5, 2002.

55. "Understanding past and future Northern Hemisphere ozone", American Meteorological Society 12th Conference on the Middle Atmosphere, San Antonio, Texas, November 4-7, 2002.

(Invited talk) International Symposium on Stratospheric Variations and Climate, Kyushu University, Fukuoka, Japan, November 12-15, 2002 (invitation declined).

(Invited talk) Fall 2002 Meeting of the American Geophysical Union, San Francisco, CA (invitation declined).

(Invited talk) Special Session on Dynamical Systems and Oceanography, Joint Annual Meeting of the American Mathematical Society and the Mathematical Association of America, Baltimore, MD, January 15-18, 2003 (invitation declined).

56. "Self-similarity of vorticity dynamics in decaying CHM turbulence", European Geophysical Society 28th General Assembly, Nice, France, April 7-11, 2003.

57. "Seasonal persistence of midlatitude total ozone anomalies", European Geophysical Society 28th General Assembly, Nice, France, April 7-11, 2003.

58. (Invited talk) "Mechanisms for stratospheric influences on tropospheric climate", SPARC Workshop on the Role of the Stratosphere in Tropospheric Climate, Whistler, B.C., April 29-May 2, 2003.

59. (Invited talk) "Modelling of chemistry-climate coupling in the middle atmosphere", Canadian Meteorological and Oceanographic Society 37th Annual Congress, Ottawa, Ontario, June 2-5, 2003.

60. "Self-similarity of vorticity dynamics in decaying CHM turbulence", American Meteorological Society 14th Conference on Atmospheric and Oceanic Fluid Dynamics, San Antonio, Texas, June 9-13, 2003.

61. (Invited talk) "Issues for stratospheric modelling and assimilation", European Centre for Medium-Range Weather Forecasts Workshop on the Stratosphere, Reading, U.K., June 23-26, 2003.

62. (Invited talk) "Large-scale transport and mixing in the middle atmosphere", International Union of Geodesy and Geophysics 23rd General Assembly, Sapporo, Japan, June 30-July 11, 2003.

63. (Invited talk) "Dynamical influences on ozone changes", International Union of Geodesy and Geophysics 23rd General Assembly, Sapporo, Japan, June 30-July 11, 2003.

64. (Invited talk) "Some issues in stratosphere-troposphere coupling", International Union of Geodesy and Geophysics 23rd General Assembly, Sapporo, Japan, June 30-July 11, 2003.

65. "Seasonal persistence of midlatitude total ozone anomalies", International Union of Geodesy and Geophysics 23rd General Assembly, Sapporo, Japan, June 30-July 11, 2003.

(Invited talk) Meeting on Optimal Transport and Nonlinear Dynamics, Pacific Institute for the Mathematical Sciences, UBC, August 11-15, 2003 (invitation declined).

66. (Invited talk) "Variability and changes in stratospheric circulation", SPARC Workshop on Understanding Seasonal Temperature Trends in the Stratosphere, Silver Spring, Maryland, November 5, 2003.

67. (Invited talk) "Stratospheric dynamics", SPARC Workshop on Process-oriented Validation of Coupled Chemistry-Climate Models, Garmisch-Partenkirchen, Germany, November 17-19, 2003.

(Invited talk) Meeting on "Geometric Methods in Geophysical Fluid Dynamics", Pitlochry, Scotland, April 20-24, 2004 (invitation declined).

(Invited talk) 3rd IAGA/ICMA Workshop on "Long-Term Changes and Trends in the Atmosphere", Sozopol, Bulgaria, June 9-14, 2004 (invitation declined).

(Invited talk) American Institute of Mathematical Sciences 5th Conference on Dynamical Systems and Differential Equations, Pomona, CA, June 16-19, 2004 (invitation declined).

(Invited talk) Asia Oceania Geosciences Society 1st Annual Meeting, Singapore, July 5-9, 2004 (invitation declined).

68. "Available potential energy and its relatives", Ed Lorenz Symposium, American Meteorological Society General Meeting, San Diego, CA, January 13, 2005.

69. (Invited talk) "Gravity-wave parameterization in the middle atmosphere", Workshop on Representing Unresolved Degrees of Freedom for the Atmosphere and Ocean, Centre de Recherches Mathématiques, Université de Montréal, March 2-4, 2005.

70. (Invited talk) "Interannual persistence of total ozone anomalies: A potential diagnostic for CCMs", SPARC GRIPS Workshop, Toronto, March 14-17, 2005.

71. (Invited talk) "Available potential energy and its relatives", European Geosciences Union General Assembly, Vienna, Austria, April 25-29, 2005.

72. "Summertime total ozone variations over middle and polar latitudes", European Geosciences Union General Assembly, Vienna, Austria, April 25-29, 2005.

73. (Invited talk) "Some issues in middle atmosphere climate modelling", Canadian Meteorological and Oceanographic Society 39th Annual Congress, Vancouver, B.C., May 31-June 3, 2005.

74. (Invited talk) "Issues in stratosphere-troposphere coupling", American Meteorological Society Joint Conference on Atmospheric and Oceanic Fluid Dynamics/Middle Atmosphere/Climate Variations, Cambridge, MA, June 13-17, 2005.

75. (Invited talk) "The role of the middle atmosphere in climate", International Association of Geomagnetism and Aeronomy Scientific Assembly, Toulouse, France, July 18-29, 2005.

76. (Invited talk) "Where do we stand as a community?", SPARC CCMVal Workshop, Boulder, CO, October 16-18, 2005.

(Invited talk) AGU Chapman Conference on Jets and Annular Structures in Geophysical Fluids, Savannah, GA, January 8-11, 2006 (invitation declined).

77. (Invited talk) "Chemistry-climate modelling of the stratosphere: A current perspective", American Geophysical Union Spring Meeting, Baltimore, MD, May 23-26, 2006.

78. (Invited talk) "Chemistry-climate modelling: A SPARC perspective", Canadian

Meteorological and Oceanographic Society 40th Annual Congress, Toronto, May 29-June 1, 2006.

(Invited talk) 17th Canadian Symposium on Fluid Dynamics, York University, June 16-18, 2006 (invitation declined).

79. (Invited talk) "Can we trust the simulated gravity-wave response to climate change?", NCAR Gravity Waves Retreat, Boulder, CO, June 26-30, 2006.

(Invited talk) Workshop on Spontaneous Imbalance, University of Washington, Seattle, WA, August 7-10, 2006 (invitation declined).

(Invited talk) Workshop on New Directions in Two-Dimensional Turbulence, Center for Nonlinear Studies, Los Alamos, August 2006 (invitation declined).

(Invited talk) Workshop on Mathematical Theory and Modelling in Atmosphere-Ocean Science, Mathematisches Forschungsinstitut Oberwolfach, Germany, August 20-26, 2006 (invitation declined).

80. (Invited talk) "Transport in the lower stratosphere: Science issues and research needs", ADM-Aeolus Workshop, European Space Agency, ESTEC, Noordwijk, Netherlands, September 26-28, 2006.

81. "On the use of CCMVal diagnostics for validating DA products", SPARC Data Assimilation Workshop, ESTEC, Noordwijk, Netherlands, October 2-4, 2006.

(Invited talk) Workshop on Multiscale Methods for GFD, University of Leiden, Netherlands, October 4-7, 2006 (invitation declined).

(Invited talk) Workshop on Vortices and Waves in Geophysical Flows, Courant Institute of Mathematical Sciences, New York, December 1-2, 2006 (invitation declined).

82. (Invited talk) "The role of the upper troposphere/lower stratosphere in the climate system", Division of Aeronomy and Space Physics, Canadian Association of Physicists Annual Congress, Saskatoon, June 17-20, 2007.

(Invited talk) Workshop on Dynamical Systems and Applications, Banff International Research Station, June 22-24, 2007 (invitation declined).

83. (Invited talk) "Current challenges in middle atmosphere science", International Union of Geodesy and Geophysics 24th General Assembly, Perugia, Italy, July 2-13, 2007.

84. (Invited talk) "Key findings from the 2006 Scientific Assessment, and a look at what lies ahead", Montreal Protocol 20th Anniversary Meeting, Montreal, 16 September 2007.

85. "How will climate change affect ozone recovery?", AGU Chapman Conference on the Role of the Stratosphere in Climate and Climate Change, Santorini, Greece, September

24-28, 2007.

86. (Invited talk) "Transport and mixing in the tropical stratosphere and upper troposphere", Reunion Island International Symposium on Tropical Stratosphere/Upper Troposphere, Reunion Island, November 5-9, 2007.

87. (Invited talk) "The scientific value of stratospheric wind measurements", NASA/NOAA Working Group on Space-based Lidar Winds, Monterey, February 5-8, 2008.

88. (Invited talk) "Advances in middle atmosphere modelling", Canadian Meteorological and Oceanographic Society 42nd Annual Congress, Kelowna, B.C., May 26-29, 2008.

89. "How will climate change affect ozone recovery?", Quadrennial Ozone Symposium, Tromsø, Norway, June 30-July 5, 2008.

90. "SPARC overview and data needs", CEOS ACC Workshop, GISS, New York, October 15-17, 2008.

91. (Invited talk) "Stratospheric modelling", Plumbfest, Columbia University, New York, October 24-25, 2008.

92. (Invited talk) "Mechanisms of chemistry-climate coupling", American Geophysical Union Spring meeting, Toronto, May 24-27, 2009.

93. (Invited talk) "Global-scale teleconnections in the Earth's middle atmosphere", American Geophysical Union Spring meeting, Toronto, May 24-27, 2009.

94. (Invited talk) "The role of dynamics in middle atmosphere modelling", International Association for Meteorology and Atmospheric Sciences, Montreal, July 19-29, 2009.

95. (Invited talk) "The role of stratospheric dynamics in chemistry-climate coupling", The One Atmosphere: IGAC-SPARC Joint Workshop, Kyoto, Japan, October 25-26, 2009.

96. (Invited talk) "The scientific case for SWIFT", Space Science Symposium in honour of the scientific career of Gordon G. Shepherd, York University, Toronto, May 27-28, 2010.

97. (Invited talk) "Global-scale teleconnections in the troposphere-stratosphere-mesosphere system", Division of Aeronomy and Space Physics, Canadian Association of Physicists Annual Congress, Toronto, June 7-10, 2010.

98. (Invited talk) "Climate sensitivity to gravity-wave drag parameterization", AGU Meeting of the Americas, Iguassu Falls, Brazil, August 9-12, 2010.

99. "Coupling between stratospheric ozone and climate: Latest results from the CMAM", AGU Meeting of the Americas, Iguassu Falls, Brazil, August 9-12, 2010.

100. (Invited talk) "Energy and momentum consistency in physical parameterization",

Workshop on small-scale variability in the general circulation of the atmosphere and oceans, University of Hamburg, Tremsbüttel, Germany, September 15-17, 2010.

101. (Invited talk) "Long-memory processes in the stratosphere", WCRP Workshop on Polar Predictability on Seasonal to Multi-Decadal Time Scales, Bergen, Norway, October 25-29, 2010.

(Invited talk) Second International Symposium on Arctic Research, Tokyo, Japan, December 7-9, 2010 (invitation declined).

102. "The role of atmospheric dynamics in ozone-climate coupling", AGU Fall Meeting, San Francisco, California, December 13-17, 2010.

103. (Invited keynote talk) "Stratospheric Processes And their Role in Climate (SPARC)", Workshop on Tropical Stratosphere-Troposphere: Implications for Indian Monsoon and Climate, Indian Institute of Tropical Meteorology, Pune, January 31–February 1, 2011.

104. (Invited talk) "Mechanisms of stratosphere-troposphere coupling in the subtropics", Workshop on Tropical Stratosphere-Troposphere: Implications for Indian Monsoon and Climate, Indian Institute of Tropical Meteorology, Pune, January 31–February 1, 2011.

105. (Invited talk) "The Brewer-Dobson circulation", Michael McIntyre 70th Birthday Celebration, University of Cambridge, UK, April 11-12, 2011.

106. (Invited talk) "Large-scale two-dimensional turbulence in the atmosphere?", Canadian Meteorological and Oceanographic Society 45th Annual Congress, Victoria, B.C., June 5-9, 2011.

107. (Invited talk) "The coupled stratosphere-troposphere response to climate change", Canadian Meteorological and Oceanographic Society 45th Annual Congress, Victoria, B.C., June 5-9, 2011.

(Invited talk) Conference on Multiple Scales in Fluid Dynamics and Meteorology, MetStroem, Free University of Berlin, Germany, June 6-10, 2011 (invitation declined).

108. "A robust mechanism for strengthening of the Brewer-Dobson circulation in response to climate change: critical-layer control of subtropical wave breaking", American Meteorological Society 18th Conference on Atmospheric and Oceanic Fluid Dynamics, Spokane, WA, June 13-17, 2011.

(Invited talk) International Union of Geodesy and Geophysics 25th General Assembly, Melbourne, Australia, June 28 – July 7, 2011 (invitation declined).

(Invited talk) Workshop on Balance, Boundaries and Mixing in the Climate Problem, Centre de Recherches Mathématiques, Université de Montréal, September 28-30, 2011 (invitation declined).

109. (Invited talk) "The ozone layer of the future: Where are we going?", International Year of Chemistry Symposium on Stratospheric Ozone and Climate Change, Washington, D.C., November 7-10, 2011.

110. (Invited talk) "Arctic climate", Science Symposium for the 140th Anniversary of the Meteorological Service of Canada, Toronto, November 24-25, 2011.

111. (Invited talk) "Stratosphere-troposphere dynamics and climate change", SPARC Workshop, ETH Zürich, February 6-7, 2012.

(Invited talk) MetStroem Workshop, Berlin, February 28-29, 2012 (invitation declined).

112. (Invited talk) "The SPARC CCMVal activity", NCAS CMIP5 Workshop, Reading, UK, April 30-May 1, 2012.

(Invited talk) Workshop on connections between rotating, stratified turbulence and climate: theory, observations, experiments and models, NCAR, Boulder, Colorado, May 14-18, 2012 (invitation declined).

113. (Invited talk) "The SPARC Perspective", IGAC/SPARC Workshop on CCM Evaluation, Davos, Switzerland, May 21-24, 2012.

(Invited talk) Canadian Applied and Industrial Mathematics Society Annual Meeting, Fields Institute, Toronto, June 24-28, 2012 (invitation declined).

114. "Mechanisms for strengthening of the Brewer-Dobson circulation under climate change", SPARC Workshop on the Brewer-Dobson Circulation, Grindelwald, Switzerland, June 25-29, 2012.

(Invited talk) AOGS-AGU Joint Assembly, Singapore, August 13-17, 2012 (invitation declined).

115. "Attributing the observed total ozone record using nudged CMAM runs", Quadrennial Ozone Symposium, Toronto, August 27-31, 2012.

116. (Invited talk) "Global-scale teleconnections in the Earth's middle atmosphere", ARISE Workshop, Reading, UK, September 18-21, 2012.

117. (Invited talk) "Model biases in dynamical variability and stratosphere-troposphere coupling in the Southern Hemisphere", Regional SPARC Workshop, Buenos Aires, Argentina, November 26-27, 2012.

118. (Invited talk) "Open questions from the previous report", NCAS Forum on the Ozone Assessment, Cambridge, UK, January 8, 2013.

(Invited talk) 8th IMACS Conference on Nonlinear Waves, Athens, Georgia, March 25-28, 2013 (invitation declined).

119. (Invited talk) "Systematic errors in model stratospheres", 4th WGNE Workshop on Systematic Errors in Weather and Climate Models, Exeter, UK, April 15-19, 2013.

120. (Invited keynote talk) "Challenges for DynVar", Joint SPARC DynVar/SNAP Workshop, Reading, UK, April 22-26, 2013.

(Invited talk) SIAM Conference on Application of Dynamical Systems, Snowbird, Utah, May 19-23 (invitation declined).

121. (Invited plenary talk) "Understanding uncertainty in climate models: Robustness of the atmospheric circulation response to climate change", Canadian Meteorological and Oceanographic Society 47th Annual Congress, Saskatoon, Sask., May 26-30, 2013.

122. (Invited talk) "Impact of Stratospheric Sudden Warmings on surface climate variability", Canadian Meteorological and Oceanographic Society 47th Annual Congress, Saskatoon, Sask., May 26-30, 2013.

123. "Attributing the observed total ozone record using nudged CMAM simulations", Canadian Meteorological and Oceanographic Society 47th Annual Congress, Saskatoon, Sask., May 26-30, 2013.

124. (Invited talk) "Polar climate predictability", ECMWF/WWRP-PPP Workshop on Polar Prediction, Reading, June 24-26, 2013.

125. (Invited keynote talk) "How predictable is the effect of climate change on atmospheric circulation?", Royal Meteorological Society Student Conference 2013, Reading, September 6-9, 2013.

126. (Invited talk) "How predictable are changes in circulation?", Royal Society Discussion Meeting on Next Steps in Climate Science, London, October 2-3, 2013.

127. (Invited talk) "How predictable are changes in atmospheric circulation?", Meeting on IPCC AR5: What have we learned, and where do we go next?, University of Cambridge, October 10, 2013.

128. (Invited talk) "Complexities of the atmospheric jet stream", RIMS International Conference on Zonal Flows in Geophysical and Astrophysical Fluids, Kyoto, November 6-8, 2013.

129. (Invited talk) "Eddy momentum fluxes/impact of gravity-wave drag on the circulation response to climate change", Royal Society International Scientific Seminar on "Robustness of the atmospheric circulation response to climate change: developing new approaches to reduce the uncertainty in regional-scale climate change projections", Chicheley Hall, Bucks., November 28-29, 2013.

(Invited talk) American Geophysical Union Fall meeting, San Francisco, December 9-13,

2013 (invitation declined).

130. (Invited talk) "Polar climate predictability", SPARC General Assembly, Queenstown, New Zealand, January 12-17, 2014.

131. (Invited talk) "Stratospheric water vapour and climate", MIT Lorenz Center Workshop on Water in the Climate System, Boston, February 10-12, 2014.

132. (Invited talk) "How predictable is the atmospheric circulation response to climate change?", WCRP Grand Challenge Workshop on Clouds, Circulation and Climate Sensitivity, Schloss Ringberg, Germany, March 24-28, 2014.

133. (Invited talk) "The role of mathematics in understanding the atmospheric circulation response to climate change", Joint RMetS/LMS Meeting on Mathematics of Planet Earth, London, April 16, 2014.

(Invited talk) Workshop on Fundamentals of Climate, Atmosphere and Ocean Dynamics, KlimaCampus, Hamburg, Germany, May 12-14, 2014 (invitation declined).

134. (Invited talk) "Attributing the observed total ozone record using nudged CMAM simulations", IGAC/SPARC Chemistry-Climate Model Initiative Workshop, Lancaster, UK, May 20-22, 2014.

135. (Invited talk) "The role of the stratosphere in extratropical circulation", Latsis Symposium 2014 on Atmosphere and Climate Dynamics, Zurich, June 18-21, 2014.

136. (Invited talk) "Polar predictability on seasonal to decadal timescales", WMO Technical Conference on Climate Services—Building on CLIPS Legacy, Heidelberg, Germany, June 30-July 2, 2014.

137. (Invited talk) "Atmospheric circulation: the wild card of climate change", CliMathNet Annual Conference, Leeds, UK, July 14-18, 2014.

(Invited talk) 40th COSPAR Scientific Assembly, Moscow, August 2-10, 2014 (invitation declined).

138. (Invited talk) "Why we need to understand mechanisms of internal variability", Royal Society International Scientific Seminar on "Uncertainty in climate variability and projections of climate change: towards a process-based understanding", Chicheley Hall, Bucks., September 16-17, 2014.

139. (Invited talk) "Potential impact of systematic errors in jet-stream position", VALUE Workshop on GCM Bias Correction, Hamburg, October 16-17, 2014.

140. (Invited talk) "How do we deal with uncertainty connected with atmospheric circulation?", PPP-PCPI International Workshop on Polar-lower latitude Linkages and

their Role in Weather and Climate Prediction, Barcelona, December 10-12, 2014.

141. (Invited talk) "Climate dynamics: the challenge of atmospheric circulation", CliMathNet Workshop on Non-equilibrium Dynamics of Climate: Linking Models to Data, Dartington Hall, Devon, January 5-7, 2015.

142. (Invited talk) "Stratosphere-troposphere coupling: are we asking the right questions?", Royal Meteorological Society Meeting on Stratosphere-troposphere coupling in the Earth System: where next?, Reading, January 21, 2015.

(Invited talk) Winter School on Theoretical Advances in Planetary Flows and Climate Dynamics, École de Physique, Les Houches, March 2-6, 2015 (invitation declined).

143. (Invited talk) "Interpretation of past total column ozone changes using a nudged chemistry-climate model", Earth System Model Validation Workshop, DLR Oberpfaffenhofen, Germany, March 13, 2015.

(Invited talk) DFG Workshop on the Energy Cycle in Atmosphere and Ocean, Hamburg, April 20-22, 2015 (invitation declined).

(Invited talk) SIAM Conference on Applications of Dynamical Systems, Snowbird, Utah, May 17-21, 2015 (invitation declined).

144. "The climate impact of past changes in halocarbons and CO_2 in the tropical UTLS region", 26th IUGG General Assembly, Prague, June 23-July 1, 2015.

145. (Invited talk) "Parameterized drag and biases in storm track dynamics", SPARC Storm Tracks Workshop, Grindelwald, Switzerland, August 24-28, 2015.

146. "On separating the forced response from variability in circulation changes over Europe", 4th European Windstorm Workshop, Bern, Switzerland, August 31-September 2, 2015.

147. "The climate impact of past changes in halocarbons and CO_2 in the tropical UTLS region", SPARC/IGAC CCMI Workshop, Rome, Italy, October 7-9, 2015.

(Invited talk) Workshop on Stratosphere-Troposphere Dynamical Coupling in the Tropics, Kyoto University, October 23-24, 2015 (invitation declined).

148. (Invited talk) "State dependence of response to forcings", IASC/CliC Workshop on Arctic/midlatitude linkages, University of Sheffield, November 3-4, 2015.

149. (Invited talk) "The scientific basis for attributing the effects of climate change", Workshop on Climate Change and Energy after Paris, University of Cambridge, January 22, 2016.

150. (Invited talk) "The climate impact of past changes in halocarbons and CO_2 in the tropical UTLS region", SHARP Workshop, Berlin, February 16-19, 2016.

(Invited talk) Royal Meteorological Society Meeting on Climate change over high southern latitudes, February 17, 2016 (invitation declined).

151. (Invited talk) "Atmospheric circulation: the wild card of climate change", DLR Conference on Climate Change 2016: Challenges for Atmospheric Research, Cologne, April 5-7, 2016.

152. (Invited talk) "Atmospheric circulation, storylines, and extremes", Workshop on the Role of Atmospheric Circulation in Regional Climate Change, University of Reading, April 13-15, 2016.

153. (Invited talk) "Atmospheric circulation, climate change, and extremes", Warwick EPSRC Symposium on Extreme Events in the Earth and planetary sciences, Mathematics Institute, University of Warwick, July 4-8, 2016.

154. (Invited talk) "Atmospheric circulation and climate change", New Fellows Seminar, Royal Society, London, July 13-14, 2016.

(Invited talk) Tohoku Forum for Creativity Thematic Program 2016 "Earth and Planetary Dynamics", Sendai, Japan, July 13-15, 2016 (invitation declined).

(Invited talk) Workshop on Multiscale Interactions in Geophysical Fluids, Mathematisches Forschungsinstitut Oberwolfach, Germany, August 14-20, 2016 (invitation declined).

155. (Invited talk) "Earth system dynamics and climate change", INQUA Early Career Researcher Conference, University of Reading, September 5-9, 2016.

(Invited keynote talk) Herrenhausen Symposium on Extreme Events, Volkswagen Foundation, Hanover, Germany, September 14-15, 2016 (invitation declined).

(Invited talk) International Symposium on the Whole Atmosphere, Tokyo, Japan, September 14-16, 2016 (invitation declined).

156. (Invited talk) "Drag and model biases", Blocking and Storm Tracks Process Evaluation Group (PEG) Meeting, Met Office, Exeter, September 19, 2016.

157. (Invited keynote talk) "Challenges of understanding atmospheric teleconnections", SPARC QBO/Teleconnections Workshop, Oxford, September 26-30, 2016.

158. (Invited talk) "Clouds, circulation and climate sensitivity", WCRP/SPARC Workshop, Berlin, October 31-November 1, 2016.

159. (Invited talk) "Patterns of climate change", Royal Society International Scientific Seminar on "Storylines as an alternative way of representing uncertainty in climate change", Chicheley Hall, Bucks., November 23-24, 2016.

(Invited talk) Symposium on Mathematics, Waves and Geophysical Flows, DFG Collaborative Research Centre, Bremen, December 15-16, 2016 (invitation declined).

160. (Invited talk) "Extreme event attribution and claims-making", Workshop on Climate Displacement and Resettlement, University of Reading, February 21, 2017.

161. (Invited talk) "Communicating uncertainty in circulation aspects of climate change", European Geosciences Union General Assembly, April 24-28, 2017.

162. (Invited talk) "Storylines as a way of characterizing compound events", European Geosciences Union General Assembly, April 24-28, 2017.

(Invited talk) Symposium on Waves, Scales, and Balances in Geophysical Fluid Flow, SIAM Conference on Applications of Dynamical Systems, Snowbird, Utah, May 21-25, 2017 (invitation declined).

163. (Invited talk) "The use of storylines in representing and communicating uncertainty in climate change", Workshop on Technological Narratives: Lessons for Artificial Intelligence, Royal Society, London, May 30, 2017.

(Invited talk) Workshop on Understanding the Causes and Consequences of Polar Amplification, Aspen Global Change Institute, Aspen, Colorado, June 11-16, 2017 (invitation declined).

164. (Invited talk) "Attribution of weather and climate extremes: The challenge of atmospheric circulation", Royal Meteorological Society Annual Meeting, Exeter, July 13-14, 2017.

165. (Invited talk) "Dynamical aspects of extreme event attribution", Joint IAPSO/ IAMAS/IAGA Assembly, Cape Town, South Africa, August 27-September 1, 2017.

166. (Invited talk) "Will storm tracks shift poleward under climate change?", Joint IAPSO/ IAMAS/IAGA Assembly, Cape Town, South Africa, August 27-September 1, 2017.

167. (Invited keynote talk) "Climate change: The challenge of uncertainty assessment and communication", Future Climate For Africa Mid-Term Conference, Cape Town, South Africa, September 4-7, 2017.

168. (Invited talk) "Global-scale teleconnections in the neutral atmosphere", Royal Astronomical Society/Royal Meteorological Society Joint Meeting on Dynamic Coupling in the Terrestrial Atmosphere, London, December 8, 2017.

(Invited talk) American Geophysical Union Fall Meeting, New Orleans, December 11-15, 2017 (invitation declined).

169. (Invited keynote talk) "Stratosphere-troposphere dynamical coupling", SPARC UTLS

workshop, Mainz, Germany, February 5-8, 2018.

170. (Invited talk) "Storylines: An alternative approach to representing uncertainty in climate change", Interdisciplinary Workshop on Urban Floods, Columbia University, USA, April 12-13, 2018.

171. (Invited talk) "Thoughts on a conditional, process-oriented approach to bias correction", 2nd Workshop on Bias Correction in Climate Studies, Santander, Spain, May 14-16, 2018.

172. (Invited talk) "Ethics and climate change", CDT Science Festival on Science and Ethics, Imperial College London, July 9, 2018.

173. (Invited talk) "Stratosphere-induced variability of SH storm tracks and its sensitivity to parameterized gravity-wave drag", Storm Tracks 2018, Utö, Stockholm, Sweden, August 27-31, 2018.

174. (Invited talk) "Storyline approaches to regional climate change", CliMathNet Conference 2018, University of Reading, UK, September 19-21, 2018.

175. "Storyline approaches to regional climate change", SPARC General Assembly, Kyoto, Japan, October 1-5, 2018.

176. (Invited talk) "Atmospheric circulation as a source of uncertainty in climate-change projections", Heldfest, Princeton University, October 29-31, 2018.

177. "Climate change: the confidence straightjacket", 4th Post-normal Science Symposium, Barcelona, Spain, November 15-17, 2018.

178. (Invited talk) "Ethics and the science of regional climate change", American Geophysical Union Fall Meeting, Washington, D.C., December 10-14, 2018.

179. (Invited talk) "Storylines as a way of understanding and representing the 'tug of war' on the atmospheric circulation response to climate change", American Geophysical Union Fall Meeting, Washington, D.C., December 10-14, 2018.

(Invited talk) Royal Meteorological Society/Grantham Institute, London, February 20, 2019 (invitation declined).

180. (Invited talk) "Storylines of regional climate change", Royal Society/British Academy Workshop on Narrative and Science, London, May 2, 2019.

(Invited talk) Workshop on Correlated Extreme Events, Columbia University, New York, May 29-31, 2019 (invitation declined).

181. (Invited talk) "Climate information: the scale challenge", Workshop on Advancing the Agenda of Regional Climate Information at the Decision Scale and in the Decision Space,

Warbrook House, Hampshire, June 3-5, 2019.

182. (Invited talk) "How do we deal with atmospheric dynamics in discussions of climate change?", Workshop on Atmospheric Dynamics and Transport in Honour of Alan Plumb, M.I.T., June 10, 2019.

183. (Invited talk) "Framing issues in extreme event attribution", 14th International Meeting on Statistical Climatology, Toulouse, France, June 24-28, 2019.

(Invited talk) 11th International Conference on Extreme Value Analysis, Zagreb, Croatia, July 1-5, 2019 (invitation declined).

184. (Invited talk) "Storyline approach to the construction of regional climate-change information", 27th IUGG General Assembly, Montreal, Canada, July 8-18, 2019.

185. (Invited talk) "Thoughts on conceptual models of wave-mean flow interaction and coupling to diabatic processes", CLICCS Workshop on Waves, Bad Segeberg, Germany, September 9-10, 2019.

(Invited talk) Workshop on Climate and Wave Dynamics, Eilat, Israel, September 22-26, 2019 (invitation declined)

186. (Invited talk) "Importance of the stratosphere for extended-range prediction", Workshop on Stratospheric Predictability and Impact on the Troposphere, ECMWF, November 18-21, 2019.

(Invited talk) Conference on Meteorology, Institute of Physics, London, UK, January 23, 2020 (invitation declined)

Invited Lectures

Geophysical Fluid Dynamics Institute, Florida State University (1989)

IFREMER, Etudes Oceaniques, Brest, France (1989)

School of Mathematics, University of Leeds (1988)

Scripps Institution of Oceanography, University of California at San Diego (1988, 2005)

Department of Meteorology, University of Stockholm (1988, 2004, 2016)

Department of Atmospheric Physics, University of Oxford (1987, 1996, 2012)

Department of Atmospheric Sciences, University of Washington, Seattle (1987, 1995)

GFD Summer School, Woods Hole Oceanographic Institution (1987, 1992)

Department of Atmospheric and Oceanic Sciences, McGill University
(1986, 1987, 1992, 1994, 1996, 1999, 2005, 2008)

Department of Oceanography, Dalhousie University (1986)

Department of Physics, University of Toronto (1986, 1987, 1996, 1999)

Institute of Ocean Sciences, Sidney, British Columbia (1986)

King's College Research Centre, Cambridge, England (1987)

Royal Meteorological Society Meeting, Oxford (1986)

Department of Applied Mathematics and Theoretical Physics, University of Cambridge
(1984, 1987, 1989, 1992, 1996, 1999, 2012)

Laboratoire de Météorologie Dynamique du CNRS, École Normale Supérieure, Paris
(1984, 1989, 1994, 1999)

Department of Meteorology, University of Reading (1984, 1988, 1999, 2011, 2012, 2013, 2014, 2016)

Department of Physics, Imperial College, London (1985, 2017)

Geophysical Fluid Dynamics Laboratory, Princeton University (1984, 1988, 1991, 1999, 2010, 2014)

Department of Earth and Atmospheric Science, York University (1988)

Department of Geophysical Sciences, University of Chicago (1990)

Department of Physics, University of California at Santa Cruz (1991)

Department of Physics, l'Université du Québec à Montréal (1992)

Department of Mechanical Engineering, University of Toronto (1991)

Institute of Atmospheric Physics, Academia Sinica, Beijing (1991)

Center for Meteorology and Physical Oceanography, Massachusetts Institute of Technology (1992, 2001, 2014)

Department of Physical Oceanography, Woods Hole Oceanographic Institution (1992)

Meteorological Service of Canada, Downsview, Ontario
(1994, 1997, 1998, 1999, 2002, 2003)

Recherche en prévision numérique, AES Dorval, Québec (1994, 1999)

Canadian Centre for Climate Modelling and Analysis, University of Victoria (1995)

Institute for Atmosphere and Climate, ETH, Zürich (1995, 2008)

Centre de Recherche en Calcul Appliqué (CERCA), Montréal (1996)

Max-Planck-Institut für Meteorologie, Hamburg (1996, 2010, 2015)

School of Mathematics, University of Bristol (1996)

Isaac Newton Institute for Mathematical Sciences, Cambridge University (1996)

Department of Mathematics, Hong Kong University of Science and Technology (1996)

Courant Institute of Mathematical Sciences, New York University (1997, 1999)

School of Earth and Ocean Sciences, University of Victoria (1998)

Department of Geophysics, Kyoto University (1998, 2004)

Department of Physics and Astronomy, University of Western Ontario (1999)

Centre for Climate and Global Change Research, McGill University (1999)

NOAA Aeronomy Laboratory, Boulder (1999)

Department of Physics and Astronomy, University of Victoria (1999)

Canadian MAM, GCC, C-SPARC and CMAM20 Project Annual Workshop (1993, 1995, 1998, 1999, 2002, 2005, 2006, 2010, 2011, 2012)

Canadian Annual Stratospheric Ozone and UV National Meeting (1999)

Institute for Scientific Computing and Applied Mathematics, Indiana University (1999)

Goddard Institute of Space Studies, NASA, New York (1999)

Departments of Physics and of Earth and Atmospheric Science, University of Alberta (1999)

Department of Mathematics, University of Alberta (1999)

Department of Mathematics, University of Toronto (1999)

Department of Earth System Science, University of California at Irvine (2000)

Canadian Institute for Theoretical Astrophysics, University of Toronto (2001, 2004)

Institut für Meteorologie, Freie Universität Berlin (2001)

Department of Atmospheric Science, Colorado State University (2002)

NOAA Climate Diagnostics Center, Boulder (2002)

National Center for Atmospheric Research, Boulder (2002, 2011)

Laboratory for Atmosphere-Hydrosphere Sciences, Kobe University (2002)

Institut für Physik der Atmosphäre, DLR Oberpfaffenhofen (2003)

Department of Physics and Astronomy, York University (2003)

Institute for Terrestrial and Planetary Atmospheres, Stony Brook University (2003)

Lamont Doherty Earth Observatory, Columbia University (2003)

Department of Applied Physics and Applied Mathematics, Columbia University (2003, 2018)

Environmental Science and Engineering, California Institute of Technology (2004, 2008)

Graduate Aeronautical Laboratories, California Institute of Technology (2004)

Center for Climate System Research, University of Tokyo (2004)

European Centre for Medium-Range Weather Forecasts (2006, 2017)

Center for Environmental and Applied Fluid Mechanics, Johns Hopkins Univ. (2008)

McGill University/Royal Society of Canada "Cutting Edge" Lectures in Science (2008)

Institute for Atmospheric Physics, University of Mainz (2009)

National Institute of Water & Atmospheric Research, Lauder, New Zealand (2011)

Department of Physics and Astronomy, University of Canterbury, New Zealand (2011)

School of Mathematical Sciences, Monash University (2011)

School of Earth Sciences, University of Melbourne (2011)

Department of Geophysics and Planetary Sciences, Tel Aviv University (2011)

Department of Solar Energy & Environmental Physics, Ben-Gurion University of the Negev (2011)

Institute of Physics, University of Rostock, Germany (2011)

Department of Geology & Geophysics, Yale University (2011)

School of GeoSciences, University of Edinburgh (2012)

School of Mathematics and Statistics, University of St. Andrews (2012)

Grantham Institute for Climate Change, Imperial College London (2012)

Research Institute for Mathematical Sciences, University of Kyoto (2012)

School of Earth and Environment, University of Leeds (2013)

Department of Mathematics, Imperial College London (2013)

Department of Physics, University of Ljubljana (2013)

College of Engineering, Mathematics and Physical Sciences, University of Exeter (2013)

Department of Mathematics, University of Surrey (2013)

School of Energy and Environment, City University of Hong Kong (2014)

Department of Mathematics, University College London (2014)

Department of Geography, University of Sheffield (2014)

NOAA Physical Sciences Division, Boulder (2014)

UK Meteorological Office, Exeter (2014)

School of Environmental Sciences, University of East Anglia (2014)

Alfred Wegener Institute for Polar & Marine Research, Potsdam (2015)

Institute for Mathematics, Free University of Berlin (2015)

Institute of Geography, University of Bern (2015)

GEOMAR, Helmholtz-Zentrum für Ozeanforschung Kiel (2016)

Department of Physics, University of Oxford (2016)

Department of Psychology, University of Essex (2017)

Department of Geography, Geoinformatics & Meteorology, University of Pretoria (2017)

South African Weather Service (2017)

Institute for Atmospheric and Environmental Sciences, University of Frankfurt (2018)

Centre for Research in Earth & Space Science, York University (2018)

Laboratoire des Sciences du Climat et de l'Environnement, Paris-Saclay (2018)

Department of Geography, University of Oxford (2019)

TEACHING AND SUPERVISION

Undergraduate Courses Taught

1990-94,99, 2000-01,03-05	PHY 351F/S, "Advanced Classical Mechanics", U. of T.
1997,98	PHY 180F, "Mechanics", U. of T. (co-taught with D. Rowe and N. Edwards)
1997-2000	PHY 459F, "Macroscopic Physics", U. of T.
2003-10,11	PHY 460S, "Nonlinear Physics", U. of T.

Graduate Courses Taught

1988,90	PHY 5101H, "Atmospheric Circulation Systems", U. of T.
1989-92	PHY 5300H, "Special Topics in Atmospheric Physics I", U. of T. (Journal Club)
1990-94,99 2003-04	PHY 5211H, "Advanced Atmospheric Dynamics", U. of T.
1993	PHY 5110Y, "Dynamical Meteorology", U. of T. (co-taught with W.R. Peltier)
1998	PHY 2502S, "Atmosphere-Ocean Dynamics", U. of T.
2000,2002	PHY 1830F, "Foundations of Atmospheric Physics", U. of T. (co-taught with J.R. Drummond)
2011	PHY 1510F, "Graduate Electromagnetism", U. of T.
2012	PHY 2504S, "Atmospheric Dynamics", U. of T.
2013,2014	MTMW20, "Global Circulation of Atmosphere and Ocean", U. of R.
2016-2019	"Mathematics of Planet Earth" (10 hours, unassessed), U. of R.

Supervision

Master's Students (Toronto)

1. Onno Bokhove, "*Hamiltonian perturbation methods in atmospheric dynamics*", 1990-1991.

2. Paul Kushner, "*Nonlinear aspects of baroclinic instability*", 1990-1991.

3. Keith Ngan, "*Mixing in geophysical fluids*", 1991-1992.

4. Kirill Semeniuk, "*Downward control and its limitations*", 1992-1993.

5. Mark Fruman, "*Models of planetary flow"*, 1998-1999.

6. James Anstey, "*Convective available potential energy"*, 2000-2001.

7. Lisa Neef, *"Kalman filter data assimilation and balanced dynamics"*, 2001-2002

8. Shuang Liang, *"Atmospheric predictability"*, 2003-2004.

9. Tiffany Shaw, *"Angular momentum and gravity wave drag"*, 2004-2005.

10. Keely O'Farrell, "*Data assimilation and transport"*, 2006-2007.

11. Joseph Fitzgerald, "*Constraints on the thermohaline circulation"*, 2008-2009.

Master's Students (Reading)

12. Adrian Tsz-Yan Leung, "*Role of initial and model errors in uncertainty of weather forecasts*", 2016-2017.

13. Elena Saggioro, "*A causal approach to climate variability in the Southern Hemisphere*", 2017-2018.

14. Swinda Falkena, *"Storyline descriptions of climate variability and change"*, 2018-2019.

Doctoral Students (Toronto)

1. Onno Bokhove, "*On balanced models in geophysical fluid dynamics*", 1991-1995.

2. Paul Kushner, "*Wave-activity conservation laws and stability theorems for semigeostrophic dynamics*", 1991-1995.

3. Keith Ngan, "*Chaotic advection in the stratosphere*", 1992-1997.

4. Djoko Wirosoetisno, "*Balance dynamics and stability of vortical flows*", 1993-1999.

5. Kirill Semeniuk, "*Mean meridional circulations in the middle atmosphere*", 1993-1999.

6. Diane Pendlebury, "*Planetary-wave-induced transport in the stratosphere*", 1995-2001.

7. Jennifer Lukovich, "*Large-scale mixing in the middle atmosphere*", 1998-2001.

8. Chuong van Tran, "*Extensive chaos and complexity of two-dimensional turbulence*", 2000-2001 (completed supervision).

9. Simal Saujani, "*Towards a unified theory of balanced dynamics*", 1998-2005.

10. Mark Fruman, "*Equatorial symmetric stability*", 1999-2005.

11. Sorin Codoban, "*Available energy of symmetric circulations, with applications to the middle atmosphere*", 2000-2007.

12. James Anstey, *"Influence of the Quasi-Biennial Oscillation on interannual variability in the Northern Hemisphere winter stratosphere"*, 2002-2009.

13. Lisa Neef, *"Balance dynamics and gravity waves in 4D data assimilation"*, 2002-2007.

14. Shuang Liang, "*Atmospheric predictability*", 2004-2007 (did not complete).

15. Tiffany Shaw, "*Energy and momentum consistency in subgrid-scale parameterization for climate models*", 2005-2009.

16. Peter Hitchcock, "*The Arctic Polar-night Jet Oscillation*", 2007-2012.

17. Martin Keller, "*Middle atmosphere data assimilation*", 2008-2011 (changed supervisors).

18. Andre Erler, "*Tropopause dynamics*", 2008-2011 (changed supervisors).

19. B. Helen Burgess, "*Two-dimensional turbulence in the atmosphere*", 2008-2014.

20. Ian Chan, "*Balance in the tropics*", 2010-2014.

Doctoral Students (Reading)

21. Annelize van Niekerk, "*Sensitivity of atmospheric circulation to orographic drag*", 2013-2017.

22. Nicholas Byrne, "*Patterns of variability of the large-scale circulation in the Southern Hemisphere*", 2013-2017.

23. Lina Boljka, "*Baroclinic and barotropic aspects of wave-mean flow interaction*", 2014-2018.

24. Andrea Gabrielski, "*Diabatic balance in the tropics*", 2015-2020.

25. Adrian Tsz-Yan Leung, "*Role of initial and model errors in uncertainty of weather forecasts*", 2017-2020.

26. Elena Saggioro, "*A causal approach to climate variability in the Southern Hemisphere*", 2018-2021.

Postdoctoral Fellows and Research Associates (Toronto)

1. Hirofumi Sakuma (Ph.D. UCLA), "*Nonlinear stability of fluid flow*", 1989-1991.

2. John Bowman (Ph.D. Princeton), "*Geophysical turbulence*", 1991-1993.

3. Hubert Shen (Ph.D. Illinois), "*Slow dynamics*", 1993-1994.

4. Xiaoqing Li (D.Phil. Oxford), "*Middle atmosphere dynamics*", 1993-1996.

5. Jacques Vanneste (Ph.D. Université Paris VI), "*Nonlinear instability*", 1995-1997.

6. John Koshyk, (Ph.D. Toronto), "*Modelling of the middle atmosphere*" (Senior Research Associate), 1994-2001.

7. Shuzhan Ren (Ph.D. Chinese Academy of Sciences), "*Balanced dynamics*", 1995-1998.

8. Serguei Medvedev (Ph.D. Siberian Branch of Russian Academy of Science, Novosibirsk), "*Hamiltonian geophysical fluid dynamics*", 1997-1998.

9. David Sankey (Ph.D. Cambridge), "*Stratospheric transport*" (Research Associate from 2001), 1998-2006.

10. Keith Ngan (Ph.D. Toronto), "*Middle atmosphere dynamics*", 1999-2000.

11. Charles McLandress (Ph.D. McGill), "*Middle atmosphere dynamics*" (Senior Research Associate), 2000-2014.

12. Lucy Campbell (Ph.D. McGill), "*Gravity waves and the QBO*", 2000-2003.

13. Shuzhan Ren (Ph.D. Chinese Academy of Sciences), "*Middle atmosphere data assimilation*" (Senior Research Associate), 2001-2011.

14. Matt Reszka (Ph.D. Alberta), "*Balance in the tropical stratosphere*", 2003-2005.

15. Yoshihiro Tomikawa (Ph.D. Tokyo), "*Waves in the polar vortex*", 2003-2004.

16. Thomas Birner (Ph.D. Munich), "*Tropopause dynamics*", 2004-2008.

17. Michaela Hegglin (Ph.D. ETH Zurich), "*Chemical structure of the UTLS*", 2005-2008.

18. Diane Pendlebury (Ph.D. Toronto), Project Manager (Research Associate), 2006-2013.

19. Andreas Jonsson (Ph.D. Stockholm), *"Chemistry-climate coupling"*, 2006-2013.

20. Susann Tegtmeier (Ph.D. AWI Potsdam), *"Ozone and stratospheric transport"*, 2006-2009.

21. Jahanshah Davoudi (Ph.D. Sharif), *"Subgridscale parameterization"* (Research Associate), 2006-2009.

22. Manuel Pulido (Ph.D. Cordoba), "*Gravity wave drag and data assimilation*", 2008-2009.

23. Magdalena Lucini (Ph.D. Cordoba), "*Optimal estimation of meteorological analyses*", 2008-2009.

24. Isla Simpson (Ph.D. Imperial), "*Dynamical responses to climate forcings*", 2009-2012.

Postdoctoral Fellows and Research Associates (Reading)

25. Yousuke Yamashita (Ph.D. Tokyo), "*Polar vortex variability*", 2012-2014.

26. Giuseppe Zappa (Ph.D. Ca' Foscari), "*Patterns of climate change*", 2014-2019.

27. Inna Polichtchouk (Ph.D. QMC), "*Drag and atmospheric circulation*", 2014-2018.

28. Felix Pithan (Ph.D. Hamburg), "*Mountain drag and atmospheric circulation*", 2015-2016.

29. Mylène Haslehner (Ph.D. Munich), "*Risk approach to circulation change*", 2015-2017.

30. Paulo Ceppi (Ph.D. Washington), "*Clouds and circulation*", 2015-2018.

31. Talia Tamarin (Ph.D. Weizmann), "*Stratosphere and climate*", 2017-present.

32. Nicholas Byrne (Ph.D. Reading), "*Seasonal prediction*", 2017-2018.

33. Hannah Young (Ph.D. Reading), "*Causal analysis of food security*", 2017-present.

34. Emanuele Bevacqua (Ph.D. Graz), "*Compound extreme events*", 2019-present.

35. Marlene Kretschmer (Ph.D. Potsdam), "*Causal analysis of Mediterranean drying*", 2019 present.

Other Lectures

1986 Gave graduate-level short course (12 lectures) on two-dimensional turbulence at D.A.M.T.P., University of Cambridge.

1989 Gave short course (5 lectures) on symmetries, conservation laws and Hamiltonian structure for fluid flow, Scripps Institution of Oceanography, University of California at San Diego.

1993 Principal Lecturer, Woods Hole Oceanographic Institution GFD Summer School. Topic: "Geometrical Methods in Fluid Dynamics" (5 lectures).

1996 Principal Lecturer and long-term participant, Research Programme on Mathematics of Atmosphere and Ocean Dynamics, Isaac Newton Institute for Mathematical Sciences, Cambridge, England (July-December).

1997 Lecturer, Summer School on the Middle Atmosphere (Cornwall, Ontario), Canadian MAM Project.

2001 Invited Lecturer, Fluid Dynamics Summer School, Pacific Institute for Mathematical Sciences, University of Alberta (2 lectures on fluid dynamics of the middle atmosphere)

2003 Invited Lecturer, Summer School on Applications of Advanced Mathematics and Computational Methods to Atmospheric and Oceanic Problems, National Center for Atmospheric Research, Boulder, USA (3 lectures on Hamiltonian geophysical fluid dynamics).

2003 Lecturer, Summer School on Global Chemistry and Climate of the Troposphere and Lower Stratosphere (Montréal), GCC Project.

2003 IGERT Distinguished Lecturer, Columbia University (3 lectures on middle atmosphere dynamics).

2004 Lecturer, Summer School on Process Studies of Atmospheric Dynamics and Chemistry by Comparison of Models and Measurements (Banff), GCC Project.

2007 Lecturer, Summer School on Atmospheric Data Assimilation and Retrieval Theory (Banff), C-SPARC Project.

2011 Sackler Lecturer, Tel Aviv University (3 lectures on stratospheric dynamics, ozone depletion, and climate change).

2012 FDEPS Lecturer, Kyoto University (5 lectures on geophysical fluid dynamics)

2013 NCAS Climate Modelling Summer School, Oxford (1 lecture on atmospheric circulation)

2015 NCAS Climate Modelling Summer School, Cambridge (1 lecture on atmospheric circulation)

2015 Autumn School on Statistical and Mathematical Tools for the Study of Climate Extremes, Institut d'Études Scientifiques de Cargèse, Corsica (2 lectures on atmospheric circulation)

2016 ECMWF Training Course on Predictability, Reading (1 lecture on the stratosphere)

2017 Les Houches Summer School on Fundamental Aspects of Turbulent Flows in Climate Dynamics, Les Houches, France (6 lectures on large-scale atmospheric dynamics)

2017 SPARC/IUGG Training School on Stratosphere-Troposphere Interactions, Cape Town, South Africa (1 lecture on psychology and climate change)

2017 NCAS Climate Modelling Summer School, Cambridge (1 lecture on atmospheric circulation)

2017 GOTHAM Summer School, Potsdam, Germany (1 lecture on atmospheric teleconnections)

2018 NERC Advanced Training Short Course on Palaeoclimate Modelling, Reading (1 lecture on uncertainty of the dynamical response to climate change)

2019 NCAS Climate Modelling Summer School, Cambridge (1 lecture on atmospheric circulation)

ADMINISTRATIVE POSITIONS

Committees within the University of Toronto

1989-1992	Publicity Committee, Physics Department
1989-1991	Graduate Regulations Committee, Physics Department
1990-1993	Colloquium Committee, Physics Department
1991-1992	Graduate Curriculum Committee, Physics Department
1991-1994	Admissions Committee, Physics Department
1991-1993	University Tribunal
1993-1994	Chair, Gender Issues Committee, Physics Department
1998	Scarborough PTR Committee, Physics Department

1999-2000	Nonlinear/Biological Physics Search Committee (two competitions)
1997-2001	Planning Committee, Physics Department
1998-2000	Promotions Committee, Physics Department
1999-2000	PTR Committee, Physics Department
1999-2001	Graduate Curriculum Committee, Physics Department
1999-2001	Undergraduate Curriculum Committee, Physics Department
2000-2001	Chair, Services Review Committee, Physics Department
2001	Prof. K. Strong's Tenure Committee
2001-2002	Theoretical Atmospheric Physics Search Committee
2002-2010	Planning Committee, Physics Department
2002-2005	Promotions Committee, Physics Department
2002-2003	Standards and Evaluations Committee, Physics Department
2002-2003	Theoretical and Experimental Atmospheric Physics Search Committee
2003	Chair, Prof. H.-Y. Kee's third-year Review Committee
2003	Prof. J. Colliander's Tenure Committee (Department of Mathematics)
2004-2010	Graduate Curriculum Committee, Physics Department (Chair from 2005)
2005-2010	Associate Chair for Graduate Studies, Physics Department
2005-2010	Chair, Graduate Admissions Committee, Physics Department
2005-2010	Chair, Standards and Evaluations Committee, Physics Department
2005-2009	NSERC PGS Chemistry, Physics and Math Selection Committee, School of Graduate Studies
2006	Experimental Atmospheric Physics Search Committee
2006-2010	PTR Committee, Physics Department
2008-2010	Promotions Committee, Physics Department
2008-2010	Committee on Student Matters, School of Graduate Studies
2010	Search Committee for Chair of Department of Physical and Environmental Sciences, University of Toronto Scarborough
2011-2012	Promotions Committee, Physics Department
2011-2012	Colloquium Committee, Physics Department
2011-2012	Standards and Evaluation Committee, Physics Department

Committees within the University of Reading

2012	Search Committee, Climate Processes (Meteorology Department)
2013	Search Committee, Analysis (Mathematics Department)
Ongoing	ERC Peer Review College

Committees Outside the University

1985-1988	Dynamics Sub-Committee, Royal Meteorological Society.
1988-1991	Committee on Atmospheric and Oceanic Waves and Stability, American Meteorological Society.
1989-2000	Education Committee, Canadian Meteorological and Oceanographic Society.
1992-2012	Chair, Scientific Steering Committee, Canadian MAM, GCC, C-SPARC and CMAM20 projects
1992-1993	Co-Convenor and Editor of Published Proceedings, 17th Stanstead Seminar "The Role of Large-Scale, Extratropical Dynamics in Climate Change", Bishop's University, Québec (June 1993).
1994-2004	Scientific Steering Group, Stratospheric Processes and their Role in Climate (SPARC), World Climate Research Programme.
1994-1995	Convenor, SPARC Workshop on Stratosphere-Troposphere Exchange (June 1995, Pointe-du-Lac, Québec).
1995-1996	Chair, Scientific Programme Committee, Canadian Meteorological and Oceanographic Society 30th Annual Congress (May 1996, Toronto).
1995-2003	International Commission on the Middle Atmosphere (ICMA).
1996	NASA Chemical Climate Modelling Review Panel
1996-1997	Convenor, Session 2.23 (Stratospheric-Tropospheric Interactions and Exchanges), IAGA 8th Scientific Assembly, Uppsala, Sweden (August 1997).
1997	Convenor, Workshop on Applications of Arnold Stability, Fields Institute, University of Toronto (June 1997).
1997	Organizer (with J.N. Koshyk), Summer School on the Middle Atmosphere, Canadian MAM Project (August 1997, Cornwall, Ontario).
1997-1998	Chapter Lead Author (with A.R. Ravishankara), 1998 WMO/UNEP Scientific Assessment of Ozone Depletion; Chapter 7: Lower Stratospheric Processes.
1998-2001	Visiting Fellowships and NATO Fellowships Selection Committee, Natural

	Sciences and Engineering Research Council.
1998-1999	Science Subvention Selection Committee, Atmospheric Environment Service
1998-1999	Co-Convenor, Sessions JSM01 (Middle atmosphere dynamics and chemistry) and JSM26 (Chemistry and transport in the upper troposphere and lower stratosphere), IUGG 22nd General Assembly, Birmingham, UK (July 1999)
1999-2000	Scientific Programme Committee, 2nd SPARC General Assembly, Mar del Plata, Argentina (November 2000)
1999-2000 2005-2008	Space and Atmospheric Environment Advisory Committee (formerly STRAC), Canadian Space Agency
1999-2001	Advisory Committee on Climate Science, Canadian Climate Program Board
1999	Contributing Author, IPCC WG1 Third Assessment Report; Chapter 7: Climate Processes
1999-2001	Editor, Journal of the Atmospheric Sciences
2001-2005	Chief Editor, Journal of the Atmospheric Sciences
1999	External Evaluator, Doctoral Program in Atmosphere-Ocean Science and Mathematics, New York University
2000-2001	Co-Convenor, SPARC Workshop on the Tropopause, Bad Tölz, Germany (April 2001)
2000-2001	Grant Review Committee, Canadian Foundation for Climate and Atmospheric Sciences
2001	Member of NSERC/CFCAS Site Visit Review Committee for CLIVAR (January 8-10) and FLUXNET (July 8-10)
2001-2002	Co-Author, 2002 WMO/UNEP Scientific Assessment of Ozone Depletion; Chapter 4: Global Ozone: Past and Future
2001-2003	Stratospheric Dynamics Mission Advisory Group, European Space Agency
2001-2004	Co-Chair, Scientific Programme Committee, 3rd SPARC General Assembly, Victoria, Canada (July 2004)
2002	Panel Reviewer, 2002 WMO/UNEP Scientific Assessment of Ozone Depletion, Les Diablerets, Switzerland, June 24-28, 2002
2003	Organizer (with D. Sankey), Summer School on Global Chemistry and Climate of the Troposphere and Lower Stratosphere, GCC Project, Montréal, Québec

	(August 2003)
2003	Scientific Programme Committee, SPARC Workshop on Process-oriented Validation of Coupled Chemistry-Climate Models, Garmisch-Partenkirchen, Germany (November 2003)
2003-2004	Editor, JAS Special Issue on the 2002 Antarctic ozone hole and stratospheric sudden warming
2003-2005	Coordinating Lead Author (with J.A. Pyle), IPCC/TEAP Special Report on Safeguarding the Ozone Layer and the Global Climate System (SROC); Chapter 1: Ozone and Climate: A Review of Interconnections
2004	Organizer (with D. Sankey), Summer School on Process Studies of Atmospheric Dynamics and Chemistry by Comparison of Models and Measurements, GCC Project, Banff, Alberta (May 2004)
2004	Contributing Author, IPCC WG1 Fourth Assessment Report; Chapter 3: Observations: Surface and Atmospheric Climate Change
2005	Organizer (with D. Sankey), Summer School on the Use of Models for the Interpretation of Atmospheric Measurements, GCC Project, Banff, Alberta (May 2005).
2005-2006	Steering Committee, 2006 WMO/UNEP Scientific Assessment of Ozone Depletion
2005	Organizer, SPARC Workshop on Stratospheric Winds, Banff, Alberta (September 2005)
2005	Scientific Programme Committee, SPARC CCMVal Workshop, Boulder, CO (October 2005)
2005-2006	European Space Agency Earth Explorer Evaluation Panel
2006	Environment Canada Science Plan External Expert Panel
2006	NSERC Strategic Networks Preapplication Review Panel, “Healthy Environment and Ecosystems” Target Area
2006-2009	Lead, Geophysical Data Analysis and Modelling, SWIFT Science Team
2007	Organizer (with D. Pendlebury), Summer School on Atmospheric Data Assimilation and Retrieval Theory, C-SPARC Project, Banff, Alberta (May 2007)

2007-2012	Co-Chair (with T. Peter and subsequently G. Bodeker), Scientific Steering Group, Stratospheric Processes and their Role in Climate (SPARC), World Climate Research Programme
2007	Scientific Programme Committee, SPARC CCMVal Workshop, Leeds, UK (June 2007)
2007-2010	Steering Committee, SPARC CCMVal Report
2007-2010	Mission Scientist, STEP Mission Concept, Canadian Space Agency
2007	Invited Participant, U.S. Climate Change Science Program Workshop on Ozone Depletion (July 2007)
2007	Panel Reviewer, U.S. National Academy of Science Board on Atmospheric Science and Climate's Committee to Review Climate Change Science Program Draft Synthesis and Assessment Product 2.4: Trends in Emissions of Ozone-Depleting Substances and Recovery (August-November 2007)
2007	Scientific Programme Committee, AGU Chapman Conference on the Role of the Stratosphere in Climate and Climate Change, Santorini (September 2007)
2007-2011	Earth Science Advisory Committee, European Space Agency
2007	Scientific Programme Committee, Reunion Island International Symposium on Tropical Stratosphere/Upper Troposphere, Reunion Island (November 2007)
2008	Organizer (with D. Pendlebury and S. Codoban), Summer School on Long-term Memory, Variability and Trends in the Climate System, C-SPARC Project, Banff, Alberta (May 2008)
2008	Specialist Advisor in Climate and Large Scale Dynamics, UK Research Assessment Exercise 2008
2008	Chair, Atmosphere Panel for ESA's Earth Explorer Selection
2009	Co-Convenor, Session A13 (The stratosphere and climate change), AGU Spring Meeting, Toronto (May 2009)
2009	Scientific Programme Committee and Co-Convenor, SPARC CCMVal Workshop, Toronto (June 2009)
2009	Lead Convenor, Session M05 (Stratosphere-troposphere-ocean coupling—Top-down or bottom-up?) and Co-Convenor, Session M06 (Theoretical advances in dynamics), IAMAS General Assembly, Montreal (July 2009)

2009-2010	Scientific Review and Advisory Group (with M.K.W. Ko and S. Solomon), 2010 WMO/UNEP Scientific Assessment of Ozone Depletion
2010	Chair, Site Visit Review Committee, NSERC CRD Proposal
2009-2010	Organizer, WCRP Workshop on Polar Predictability on Seasonal to Multi-Decadal Time Scales, Bergen, Norway (October 2010)
2010-2011	Scientific Organizing Committee, WCRP Open Science Conference, Denver, USA (October 2011)
2010-2012	AGU Fellows Committee for Atmospheric Sciences
2010-2013	Review Editor, IPCC WG1 Fifth Assessment Report; Chapter 11: Near-Term Climate Change: Projections and Predictability
2012	Atmospheric Physics and Atmospheric Composition Panels, European Space Agency's ISS Selection
2012	Organizer, WCRP/IASC Workshop on Polar Climate Predictability, Toronto (April 2012)
2011-2012	Scientific Programme Committee, IGAC/SPARC Global Chemistry-Climate Modeling and Evaluation Workshop, Davos, Switzerland (May 2012)
2011-2012	Co-Convenor, SPARC Workshop on the Brewer-Dobson Circulation, Grindelwald, Switzerland (June 2012)
2012-2015	Co-Chair (with C. Bitz), WCRP Polar Climate Predictability Initiative
2012-2015	Steering Committee, SPARC/IGAC Chemistry-Climate Model Initiative
2013-2014	Steering Committee, 2014 WMO/UNEP Scientific Assessment of Ozone Depletion
2013	Organizer, Royal Society International Scientific Seminar on "Robustness of the atmospheric circulation response to climate change: developing new approaches to reduce the uncertainty in regional-scale climate change projections", Chicheley Hall, Bucks., UK (November 2013)
2013-present	Co-lead (with A. Sobel), "Changing patterns" initiative of the WCRP Grand Challenge activity on Clouds, Circulation and Climate Sensitivity
2013-2015	Member, COSPAR "Integrated Earth System Science Roadmap" Study Group
2014	Organizer, Royal Society International Scientific Seminar on "Uncertainty in

	climate variability and projections of climate change: towards a process-based understanding", Chicheley Hall, Bucks., UK (September 2014)
2013-2014	Selection Panel, Royal Society University Research Fellowships (URF)
2014-2017	Royal Society of Canada Fellows Committee for Earth, Ocean and Atmospheric Sciences
2014-2016	Core member of NERC Peer Review College
2014-present	Met Office Hadley Centre Science Review Group (Chair from 2017)
2014	PhD External Examiner, Oxford University (Peter Watson)
2014-2015	Lead Convenor, Session C16 (The Cryosphere and Polar Amplification of Climate), IUGG General Assembly, Prague (July 2015)
2015-2016	Committee on Extreme Weather Events and Climate Change Attribution, US National Academy of Sciences
2016-2018	Peer Review Panel for UKCP18
2016	Organizer, 2nd UK National Climate Dynamics Workshop, University of Reading (July 2016)
2016	Scientific Organizing Committee, ECMWF-WCRP-WWRP Workshop on Drag Processes and their Links to Large-scale Circulation, ECMWF, Reading (September 2016)
2016, 2017	Royal Society Challenge Grants Committee
2016	Organizer, Royal Society International Scientific Seminar on "Storylines as an alternative way of representing uncertainty in climate change", Chicheley Hall, Bucks., UK (November 2016)
2016	Science Advisory Board, ACSIS
2018-present	Royal Society Hooke Committee
2019-present	Royal Society Science Policy Expert Advisory Committee
2019	Scientific Organizing Committee, Workshop on Physical Modelling Supporting a 'Storyline Approach', Oslo, Norway (April 2019)
2019	Scientific Organizing Committee, Workshop on Advancing the Agenda of Regional Climate Information at the Decision Scale and in the Decision Space,

Warbrook House, Hampshire, UK (June 2019)