

CURRICULUM VITAE

William W. Hsieh

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Citizenship: Canadian

Education:

1972-1976: University of British Columbia
B.Sc. in Combined Honours Mathematics and Physics

1976-1978: University of British Columbia
M.Sc. in Physics
Thesis (supervised by J.M. McMillan): "A new Hamiltonian for systems of nucleons and pions."

1978-1981: University of British Columbia
Ph.D. in Physics and Oceanography
Thesis (supervised by L.A. Mysak): "Resonant interactions between continental shelf waves."

Professional Positions:

1981-1982: University of Cambridge
Postdoctoral Fellow in the Department of Applied Mathematics and Theoretical Physics (under A.E. Gill)

1983-1985: University of New South Wales
1983: ARGS Research Associate in the School of Mathematics (under V.T. Buchwald).
1984-85: Queen's Fellow in Marine Science.

1985-present: University of British Columbia
1985-86: Research Associate
1986-1990: Assistant Professor of Oceanography
1990-93: Assistant Professor of Oceanography and Physics
1993-96: Associate professor of Oceanography and Physics
1996-2001: Associate Professor of Earth & Ocean Sciences, and Physics & Astronomy

2001-2010: Professor of Earth & Ocean Sciences, and Physics & Astronomy
 2002-2007, 2008-2010: Chair of the Atmospheric Science Programme
 2010-: Professor emeritus of Earth, Ocean & Atmospheric Sciences

2016-present: Visiting scientist, School of Earth and Ocean Sciences, University of Victoria, BC, Canada

1992: Visiting Fellow, Program in Atmospheric and Oceanic Sciences, Princeton University.

Awards:

Canadian Meteorological and Oceanographic Society Graduate Student Prize for 1981. Citation: "for outstanding contributions to dynamic oceanography" in my Ph.D. thesis work.

NSERC Postdoctoral Fellowship, held at the University of Cambridge, 1981-82.

Australian Queen's Fellowship in Marine Science, held at the University of New South Wales, 1984-85.

UBC Killam Faculty Research Fellowship 1992-93.

Canadian Meteorological and Oceanographic Society President's Prize for 1999. Citation: "for his outstanding contribution to global climate research through the development and application of neural network techniques for the analysis and forecasting of climate variability".

Peter Wall Inst. for Advanced Studies: Distinguished UBC Scholar in Residence, 2000

Fellow of the Canadian Meteorological and Oceanographic Society, 2010. Citation: "for his internationally recognized leadership in the application of artificial neural networks to the advancement of our understanding of meteorological, oceanographic and climate variability"

[John Patterson medal](#) (2013), Meteorological Service of Canada.

Teaching:

Postgraduate and undergraduate courses in Physical Oceanography and Atmospheric Science (dynamic oceanography, satellite oceanography, dynamic meteorology, geophysical fluid dynamics, climate system, natural disasters)

Postgraduate course in statistical/machine learning methods, including an online version: <http://www.ocgy.ubc.ca/~william/EOSC510/index.html>

Undergraduate courses in Physics.

Session	Course Number	Scheduled Hours/wk	Class Size	Hours Taught			
				Lectures	Tutorials	Labs	Other (Office Hrs)
1985-86	PHYS 421	2	64	26			

1986-87	PHYS 421	2	32	26			
1986-87	OCGY 514	2	5	48			
1986-87	OCGY 516	2	4	24			
1987-88	PHYS 421	3	28	39			
1987-88	OCGY 514	2	4	48			
1987-88	OCGY 510		3		18		
1987-88	OCGY 449		1				12
1988-89	OCGY 514	2	7	48			
1988-89	ATSC/OCGY 414	3	9	39			
1988-89	OCGY 516	2	7	24			
1988-89	OCGY 505A		1				12
1989S	OCGY 448		1				
1989-90	OCGY 514	2	4	48			
1989-90	ATSC/OCGY 414	3	18	39			
1989-90	OCGY 526	3	9	18			
1990-91	ATSC/OCGY 414	3	14	39			
1990-91	OCGY 516	2	5	24			
1990-91	PHYS 312	3	29	39			
1990-91	PHYS 153	1	48		12		
1991-92	ATSC/OCGY 414	3	14	39			
1991-92	OCGY 526	3	9	18			
1991-92	PHYS 312	3	34	39			
1991-92	PHYS 153	1 (2 sect.)	48		24		
1993-94	ATSC/OCGY 414	3	21	39			
1993-94	OCGY 308	3	177	35			
1993-94	OCGY 526	3	11	18			
1993-94	PHYS 306	3	20	39			
1993-94	PHYS 349B		1				12
1993-94	PHYS 449		1				12
1994-95	ATSC/OCGY 414	3	10	39			
1994-95	OCGY 308	3	268	35			
1994-95	PHYS 306	3	17	39			

1995-96	OCGY 308	3	254	35			
1995-96	OCGY 449		1				12
1995-96	OCGY 526	3	9	18			
1995-96	PHYS 153	3 (2 sect.)	46, 48			72	
1995-96	PHYS 102	1 (4 sect.)	40,40,40,40		48		
1996-97	OCGY 308	3	244	35			
1996-97	OCGY 405	3	16	39			
1996-97	PHYS 314	3	18	39			
1996-97	PHYS 102	1 (3 sect.)	40, 54, 51		36		
1996-97	PHYS 449		1				12
1997-98	OCGY 308	3	225	35			
1997-98	PHYS 314	3	10	39			
1997-98	OCGY 526	3	6	18			
1997-98	PHYS 102	1 (3 sect.)	40, 40, 40		36		
1997-98	PHYS 449		1				12
1998-99	OCGY 308	3	268	33			
1998-99	PHYS 314	3	24	39			
1998-99	OCGY 505A	2	8	24			
1998-99	PHYS 170	1 (2 sect.)	40, 40		24		
1998-99	PHYS 449		1				12
1998-99	OCGY 449		1				3
1999-00	OCGY 308	3	281	33			
1999-00	PHYS 314	3	27	39			
1999-00	EOSC 502	3	8	35			
1999-00	OCGY 449		1				12
2001-02	EOSC 510	3	13	36			
2001-02	EOSC 114	3 (3 sect.)	132,244,63	15			
2001-02	EOSC 112	3	80	5			
2001-02	EOSC 314	3	289	9			
2001-02	PHYS 314	3	21	36			
2002-03	EOSC 510	3	6	36			
2002-03	EOSC 114	3 (3 sect.)	149,177,244	16			
2002-03	EOSC 112	3	133	17			
2002-03	PHYS 314	3	20	36			

2003-04	ATSC 404	3	17	27		
2003-04	EOSC 112	3 (2 sect.)	75, 82	19, 20		
2003-04	PHYS 314	3	32	39		
2004-05	EOSC 112	3	80	19		
2004-05	EOSC 114	3	211	5		
2004-05	EOSC 510	3	6	36		
2004-05	PHYS 100	1 (2 sect.)	44, 44		24	
2004-05	PHYS 314	3	35	37		
2004-05	PHYS 349		1			6
2005-06	ATSC 404	3	22	37		
2005-06	EOSC 112	3	109	19		
2005-06	PHYS 170	1	53		11	
2005-06	PHYS 314	3	28	36		
2005-06	PHYS 449		1			6
2006-07	PHYS 170	2	~53x2		22	
2006-07	PHYS 314	3	19	36		
2006-07	EOSC 510	3	8	39		
2006-07	ATSC 414/EOSC 477	3	12	26		
2008-09	PHYS 314	3	27	37		
2008-09	EOSC 510	3	9	36		
2008-09	EOSC 112	3	155	20		
2009-10	PHYS 314	3	21	36		
2009-10	ATSC 404	3	17	39		
2009-10	EOSC 112	3	171	19		
2010-11	EOSC 510	1.5	5	20		
2011-12	EOSC 510	3	6	36		
2013-14	EOSC 510	3	12	38 (online)		

Membership in professional societies:

1. Canadian Meteorological and Oceanographic Society

2. American Meteorological Society
3. American Geophysical Union
4. International Neural Network Society
5. European Geosciences Union

Committees & Miscellaneous Services (outside UBC):

- Member of the Scientific Committee, Canadian Meteorological & Oceanography Society (1988 - 91), Secretary (1990 - 91)
- Member of the Prizes and Awards Committee, Canadian Meteorological and Oceanographic Society (1991-94)
- Chair of the Scientific Program Committee of the Canadian Meteorological and Oceanographic Society 1995 Congress (1994-95)
- CMOS/CICS 1997 Tour Speaker: "Neural Networks for Short-term Climate Prediction", Halifax (97/10/17), Montreal (97/10/20), Ottawa (97/10/22), Toronto (97/10/23), Vancouver (97/11/27), Sidney (97/12/4), Victoria (97/12/5), Edmonton (97/12/9), Saskatoon (97/12/10), Winnipeg (97/12/11).
- Member of the Committee on Artificial Intelligence applications to Environmental Science, American Meteorological Society (1999-2002, 2005-2011).
- Member of the Scientific Program Committee of the Canadian Meteorological and Oceanographic Society (1999-2000, 2007-2008, 2014-)
- Canadian Meteorological and Oceanographic Society BC Lower Mainland Centre: Treasurer (2000-2010) and Chair (2010-).
- Member of the Prizes and Awards Committee, Canadian Meteorological and Oceanographic Society (2004-2006)
- Treasurer, Canadian Meteorological and Oceanographic Society 2005 Congress (2004-2005).
- Chair of the Prizes and Awards Committee, Canadian Meteorological and Oceanographic Society (2006-2007)
- Co-editor: Neural Networks: Special issue on "Computational Intelligence in Earth and Environmental Sciences" (2006-07).
- Member of the University and Professional Education Committee, Canadian Meteorological and Oceanographic Society (2006-2010)
- Member of Technical Committee, IEEE World Congress on Computational Intelligence, 2008
- Member of the Editorial Board of the International Journal of Oceanography (2008-2011)
- Editor of Nonlinear Processes in Geophysics (2010-2015)
- Editor-in-chief of Atmosphere-Ocean (2010-2013). Associate editor (2013-)
- Member of Editorial Advisory Board of the Atmospheric and Oceanographic Sciences Library, Springer (2011-)

Invited Symposia Lectures (since 1999):

- “Nonlinear principal component analysis by neural network models”. European Geophysical Society XXIV General Assembly. 19-23 April 1999, The Hague, Netherlands.
- “Forecasting the equatorial Pacific sea surface temperatures by neural network models”. European Geophysical Society XXIV General Assembly. 19-23 April 1999, The Hague, Netherlands.
- "Neural networks for nonlinear multivariate data analysis", and "Neural networks for nonlinear time series analysis". Amer. Meteorol. Soc. Short Course on Neural Network Applications to Environmental Sciences, 12-13 Jan. 2002. Orlando, Florida.
- “From principal component analysis (PCA), to nonlinear PCA” and “Nonlinear principal component analysis and extensions”. Amer. Meteorol. Soc. Short Course on Artificial Intelligence Methods in Atmospheric and Oceanic Sciences: Neural Networks, Fuzzy Logic, and Genetic Algorithms, 10-11 Jan., 2004, Seattle, WA.
- “Non-linear modes of climate variability via neural network methods”. European Geophysical Society Congress. 25-29 April, 2005, Vienna, Austria.
- “Nonlinear principal component analysis of noisy data”, Amer. Meteorol. Soc. Annual Meeting, 14-18 Jan., 2007, San Antonio, Texas.
- “Nonlinear principal component analysis of noisy data”. European Geophysical Society Congress. 16-20 April, 2007, Vienna, Austria.
- “Modes of climate variability, their changes, and their detection by machine learning methods”, keynote speaker at the 5th Annual Northern High Performance Computing Spring Conference, Univ. Northern British Columbia, 14 May, 2007, Prince George, B.C.
- “Downscaling by kernel methods”, National Workshop on “Climate Scenarios of Extremes for Impact and Adaptation studies”, 6-8 May, 2008, Montreal, Quebec.
- “Machine learning methods in climate and weather research”. IEEE International Conference on Data Mining, Workshop on “Knowledge discovery from climate data: prediction, extremes, and impacts” keynote speaker, 11 Dec 2011, Vancouver, BC

Research contributions

My research interests have evolved over the years: I started in low-frequency wave dynamics over the continental shelf, then broadened into ocean circulation and climate variability. Through climate, I became interested in atmospheric sciences, hydrology, fisheries and agricultural science. Interests in modelling and predicting climate variability, especially the El Niño phenomenon, led me to machine learning (a major branch of artificial intelligence) in the early 1990s – this was a lucky switch since within a few years, the spectacular rise of the internet spurred the wide use of machine learning to extract information from the massive internet data.

My most important research accomplishment has been in the development and application of machine learning methods (esp. neural networks) in climate and meteorological research. My group has been able to show that neural networks offer a nonlinear generalization of the current multivariate data analysis methods (e.g. principal component analysis, canonical correlation analysis and multichannel singular spectrum analysis) used in the environmental sciences. More specifically, my student Alex Cannon and I invented a new neural network architecture for nonlinear canonical

correlation analysis. With my research associate Aiming Wu, we invented nonlinear multichannel singular spectrum analysis, and discovered nonlinear atmospheric teleconnections. Together with my student Adam Monahan, we popularized the introduction of nonlinear principal component analysis into environmental sciences. With my student Youmin Tang, we studied how neural networks can be combined with dynamical models to form hybrid models. With my student Aranildo Lima, we developed nonlinear updatable model output statistics (UMOS), with UMOS being essential in the post-processing of numerical weather prediction. With other students and post-docs, machine learning methods were used as nonlinear regression and classification models for post-processing and downscaling numerical model output for climate (esp. extreme climate) and weather, and for data analysis and prediction.

My nonlinear principal component analysis and nonlinear canonical correlation analysis programs (in MATLAB), downloadable from our web site (<http://www.ocgy.ubc.ca/projects/clim.pred/download.html>) since Jan., 2001, have registered users from about 80 countries.

As existing data analysis books in atmospheric and related sciences were entirely based on statistics instead of the newer field of machine learning, I wrote a graduate level text “Machine Learning Methods in the Environmental Sciences”, Cambridge Univ. Press, 2009 (<http://www.cambridge.org/catalogue/catalogue.asp?isbn=9780521791922>). I am currently writing a new textbook, with the tentative title “Learning from Environmental Data”, for senior undergraduate and graduate students in the environmental sciences.

Our group produced the first El Niño/La Niña forecast model in Canada using neural networks, with the forecasts posted monthly on our web site (www.ocgy.ubc.ca/projects/clim.pred) since 1997. Our forecasts are displayed in the Summary of ENSO Model Forecasts issued monthly by the International Research Institute for Climate Prediction (http://iri.columbia.edu/climate/ENSO/currentinfo/SST_table.html).

Career publication list: (ISI *h*-index = 24; Google Scholar *h*-index = 32)

In multi-authored journal publications, the student or post-doc who does most of the hands-on work is the first author. Students are listed in **bold** font.

1. **REFEREED PUBLICATIONS**

(a) ***Journals***

102. **Lima, A.R.**, W.W. Hsieh and A.J. Cannon. Variable complexity online sequential extreme learning machine, with applications to streamflow prediction. *J. Hydrology*. (accepted 2017/10/19).
101. **Snauffer, A.M.**, W.W. Hsieh and A.J. Cannon, 2016. Comparison of gridded snow water equivalent products with in situ measurements in British Columbia, Canada. *J. Hydrology*, 541:714-726. <http://dx.doi.org/10.1016/j.jhydrol.2016.07.027>
100. **Peng, H.**, **A.R. Lima**, A. Teakles, J. Jin, A.J. Cannon and W.W. Hsieh, 2016. Evaluating hourly air quality forecasting in Canada with nonlinear updatable machine learning methods. *Air Quality, Atmosphere and Health*. <http://link.springer.com/article/10.1007/s11869-016-0414-3>
99. **Lima, A.R.**, A.J. Cannon and W.W. Hsieh, 2016. Forecasting daily streamflow using online sequential extreme learning machines. *J. Hydrology*, 537:431-443.

98. **Johnson, M.D.**, W.W. Hsieh, A.J. Cannon, A. Davidson, F. Bédard, 2016. Crop yield forecasting on the Canadian Prairies by remotely sensed vegetation indices and machine learning methods. *Agricultural and Forest Meteorology*, 218-219:74-84.
97. **Lima, A.R.**, A.J. Cannon and W.W. Hsieh, 2015. Nonlinear regression in environmental sciences using extreme learning machines: A comparative evaluation. *Environmental Modelling & Software machines*. *Environmental Modelling & Software* 73:175-188.
96. Matsumura, K., **C.F. Gaitan**, K. Sugimoto, A.J. Cannon and W.W. Hsieh, 2015. Maize yield forecasting by linear regression and artificial neural networks in Jilin, China. *The Journal of Agricultural Science, Cambridge*, 153:399-410.
95. **Gaitan, C.F.**, W.W. Hsieh and A.J. Cannon, 2014. Comparison of statistically downscaled precipitation in terms of future climate indices and daily variability for southern Ontario and Quebec, Canada. *Climate Dynamics* 43:3201-3217.
94. **Gaitan, C.F.**, W.W. Hsieh, A.J. Cannon and P. Gachon, 2013. Evaluation of linear and non-linear downscaling methods in terms of daily variability and climate indices: surface temperature in Ontario and Quebec, Canada. *Atmosphere-Ocean* 52:211-221, doi: 10.1080/07055900.2013.857639
93. **Lima, A.R.**, A.J. Cannon and W.W. Hsieh, 2013. Nonlinear regression in environmental sciences by support vector machines combined with evolutionary strategy. *Computers & Geosciences*, 50:136-144. <http://dx.doi.org/10.1016/j.cageo.2012.06.023>.
92. Finnis, J., W.W. Hsieh, H. Lin and W. Merryfield, 2012. Nonlinear post-processing of numerical seasonal climate forecasts. *Atmos.-Ocean*, 50:207-218. DOI:10.1080/07055900.2012.667388.
91. **Rasouli, K.**, W.W. Hsieh and A.J. Cannon, 2012. Daily streamflow forecasting by machine learning methods with weather and climate inputs. *J. Hydrology*, 414-415: 284-293. doi:10.1016/j.jhydrol.2011.10.039.
90. Jenkner, J., W.W. Hsieh and A.J. Cannon, 2011. Nonlinear seasonal modulations of the active MJO cycle. *Mon. Wea. Rev.*, 139:2259-2275. doi: 10.1175/2010MWR3562.1
89. Zeng, Z., W.W. Hsieh, W.R. Burrows, A. Giles and A. Shabbar, 2011. Surface wind speed prediction in the Canadian Arctic using nonlinear machine learning methods. *Atmos.-Ocean*, 49(1): 22-31, DOI: 10.1080/07055900.2010.549102.
88. Zeng, Z., W.W. Hsieh, A. Shabbar and W.R. Burrows, 2011. Seasonal prediction of winter extreme precipitation over Canada by support vector regression. *Hydrol. Earth Syst. Sci.*, 15:65-74, doi: 10.5194/hess-15-65-2011
87. **Choi, J.**, S.-I. An, B. Dewitte and W.W. Hsieh, 2009. Interactive feedback between the tropical Pacific Decadal Oscillation and ENSO in a coupled general circulation model. *J. Climate* 22:6597-6611.
86. **Aguilar-Martínez, S.** and W.W. Hsieh, 2009. Forecasts of tropical Pacific sea surface temperatures by neural networks and support vector regression. *Int. J. Oceanography*, vol. 2009, Article ID 167239, 13 pages. doi:10.1155/2009/167239.
85. **Ye, Z.** and W.W. Hsieh, 2008. Enhancing predictability by increasing nonlinearity in ENSO and Lorenz systems. *Nonlin. Processes in Geophys.* 15:793-801.
84. **Ye, Z.** and W.W. Hsieh, 2008. ENSO and associated overturning circulations from enhanced greenhouse gases. *J. Climate*, 21:5745-5763.
- 83* **Cannon, A.J.** and W.W. Hsieh, 2008. Robust nonlinear canonical correlation analysis: application to seasonal climate forecasting. *Nonlin. Processes in Geophys.* 15: 221-232.
82. Wong, C.S., L. Xie, W.W. Hsieh, 2007. Variations in nutrients, carbon and other hydrographic parameters related to the 1976-77 and 1988-89 regime shifts in the sub-arctic northeast Pacific. *Prog. Oceanogr.* 75: 326-342. doi:10.1016/j.pocean.2007.08.002
- 81* Hsieh, W.W., 2007. Nonlinear principal component analysis of noisy data. *Neural Networks* 20: 434-443. DOI 10.1016/j.neunet.2007.04.018.
80. Wu, A., W.W. Hsieh, G.J. Boer and F.W. Zwiers, 2007. Changes in the Arctic Oscillation under increased atmospheric greenhouse gases. *Geophys. Res. Lett.* 34, L12701, doi:10.1029/2007GL029344.
79. An, S.-I., **Z. Ye** and W.W. Hsieh, 2006. Changes in the leading ENSO modes associated with the late 1970s climate shift: Role of surface zonal current. *Geophys. Res. Lett.* 33, L14609, doi: 10.1029/2006GL026604.
78. **Lainé, A.**, W.W. Hsieh and H.J. Freeland, 2006. Forcing mechanisms controlling surface and subsurface temperature anomalies along Line-P, northeast Pacific Ocean. *Atmos.-Ocean*, 44: 163-176.
77. Hsieh, W.W., A. Wu and A. Shabbar, 2006. Nonlinear atmospheric teleconnections. *Geophys. Res. Lett.* 33, L07714, doi:10.1029/2005GL025471.

76. Wu, A., W.W. Hsieh and B. Tang, 2006. Neural network forecasts of the tropical Pacific sea surface temperatures. *Neural Networks*, 19: 145-154.
75. Wu, A., W.W. Hsieh, A. Shabbar, G.J. Boer and F.W. Zwiers, 2006. The nonlinear association between the Arctic Oscillation and North American winter climate. *Clim. Dynam.* 26:856-879. DOI: 10.1007/s00382-006-0118-8.
74. Ye, Z. and W.W. Hsieh, 2006. The influence of climate regime shift on ENSO. *Clim. Dynam.*, 26:823-833. DOI: 10.1007/s00382-005-0105-5.
73. An, S.-I., W.W. Hsieh and F.-F. Jin, 2005. A nonlinear analysis of the ENSO cycle and its interdecadal changes. *J. Climate*, 18: 3229-3239.
72. Li, S., W.W. Hsieh and A. Wu, 2005. Hybrid coupled modeling of the tropical Pacific using neural networks. *J. Geophys. Res.* 110, C09024, 10.1029/2004JC002595.
71. Jamet, C. and W.W. Hsieh, 2005. The nonlinear atmospheric variability in the winter northeast Pacific associated with the Madden-Julian Oscillation. *Geophys. Res. Lett.* 32(13), L13820, DOI: 10.1029/2005GL023533.
70. **Rattan, S.S.P.**, B.G. Ruessink and W.W. Hsieh, 2005. Nonlinear complex principal component analysis of nearshore bathymetry. *Nonlin. Processes in Geophys.* 12: 661-670.
69. Wu, A., W.W. Hsieh and A. Shabbar, 2005. The nonlinear patterns of North American winter temperature and precipitation associated with ENSO. *J. Climate* 18: 1736-1752. doi: 10.1175/JCLI3372.1
68. **Rattan, S.S.P.** and W.W. Hsieh, 2005. Complex-valued neural networks for nonlinear complex principal component analysis. *Neural Networks*, 18: 61-69, doi:10.1016/j.neunet.2004.08.002.
67. **Rattan, S.S.P.** and W.W. Hsieh, 2004. Nonlinear complex principal component analysis of the tropical Pacific interannual wind variability. *Geophys. Res. Lett.* 31, no. 21, L21201, DOI: 10.1029/2004GL020446.
66. Wu, A. and W.W. Hsieh, 2004. The nonlinear association between ENSO and the Euro-Atlantic winter sea level pressure. *Clim. Dynam.* 23: 859-868. DOI: 10.1007/s00382-004-0470-5.
- 65* Hsieh, W.W., 2004. Nonlinear multivariate and time series analysis by neural network methods. *Reviews of Geophysics*, 42, RG1003, doi:10.1029/2002RG000112.
64. Wu, A. and W.W. Hsieh, 2004. The nonlinear Northern Hemisphere atmospheric response to ENSO. *Geophys. Res. Lett.* 31, L02203, doi:10.1029/2003GL018885
63. Wu, A. and W.W. Hsieh, 2003. Nonlinear interdecadal changes of the El Nino-Southern Oscillation. *Clim. Dynam.* 21: 719-730. DOI 10.1007/s00382-003-0361-1.
62. **Newbigging, S.C.**, L.A. Mysak and W.W. Hsieh, 2003. Improvements to the Nonlinear Principal Component Analysis method, with applications to ENSO and QBO. *Atmos.-Ocean*, 41(4): 291-299.
61. Hsieh, W.W. and K. Hamilton, 2003. Nonlinear singular spectrum analysis of the tropical stratospheric wind. *Q. J. R. Meteorol. Soc.* 129: 2367-2382.
60. Wu, A., W.W. Hsieh, and F.W. Zwiers, 2003. Nonlinear modes of North American winter climate variability detected from a general circulation model. *J. Climate* 16(14): 2325-2339
59. **Yuval**, and W.W. Hsieh, 2003. An adaptive nonlinear MOS scheme for precipitation forecasts using neural networks. *Weather and Forecasting*, 18(2): 303-310.
58. **Tang, Y.** and W.W. Hsieh, 2003. Nonlinear modes of decadal and interannual variability of the subsurface thermal structure in the Pacific Ocean. *J. Geophys. Res.* 108(C3), DOI: 10.1029/2001JC001236.
57. Hsieh, W.W., **Yuval**, J. Li, A. Shabbar and S. Smith, 2003. Seasonal prediction with error estimation of Columbia River streamflow in British Columbia. *J. Water Resour. Plng. and Mgmt.* 129(2): 146-149.
56. **Tang, Y.** and W.W. Hsieh, 2003. ENSO simulation and prediction in a hybrid coupled model with data assimilation. *J. Meteorol. Soc. Japan*, 81:1-19.
55. Wu, A., W.W. Hsieh and A. Shabbar, 2002. Nonlinear characteristics of the surface air temperature over Canada. *J. Geophys. Res.* 107(D21), DOI: 10.1029/2001JD001090
- 54* **Yuval**, and W.W. Hsieh, 2002. The impact of time-averaging on the detectability of nonlinear empirical relations. *Quart. J. Roy. Met. Soc.* 128: 1609-1622.
53. Hamilton, K. and W.W. Hsieh, 2002. Representation of the QBO in the tropical stratospheric wind by nonlinear principal component analysis. *J. Geophys. Res.* 107(D15), DOI: 10.1029/2001JD001250
52. Wu, A. and W.W. Hsieh, 2002. Nonlinear canonical correlation analysis of the tropical Pacific wind stress and sea surface temperature. *Clim. Dynam.* 19: 713-722. DOI 10.1007/s00382-002-0262-8.
- 51* Hsieh, W.W. and A. Wu, 2002. Nonlinear multichannel singular spectrum analysis of the tropical Pacific climate variability using a neural network approach. *J. Geophys. Res.* 107(C7), DOI: 10.1029/2001JC000957.

50. **Tang, Y.** and W.W. Hsieh, 2002. Hybrid coupled models of the tropical Pacific -- ENSO prediction. *Clim. Dynam.* 19: 343-353.
- 49* Hsieh, W.W., 2001. Nonlinear principal component analysis by neural networks. *Tellus* 53A: 599-615.
48. Hsieh, W.W. and B. Tang, 2001. Interannual variability of accumulated snow in the Columbia basin, British Columbia. *Water Resources Res.* 37: 1753-1759.
- 47* Hsieh, W.W., 2001. Nonlinear canonical correlation analysis of the tropical Pacific climate variability using a neural network approach. *J. Climate* 14: 2528-2539.
46. Haigh, S.P., K.L. Denman and W.W. Hsieh, 2001. Simulation of the plankton ecosystem response to pre- and post-1976 forcing in an isopycnic model of the North Pacific. *Can. J. Fish. Aquat. Sci.* 58: 703-722.
45. **Tang, Y.** and W.W. Hsieh, 2001. Coupling neural networks to incomplete dynamical systems via variational data assimilation. *Mon. Wea. Rev.* 129: 818-834.
44. **Tang, Y.,** W.W. Hsieh, B. Tang and K. Haines, 2001. A neural network atmospheric model for hybrid coupled modelling. *Climate Dynamics* 17: 445-455.
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4. **WORK SUBMITTED**

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THESES SUPERVISED:

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