

Dr. Gregory S. Duane

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PROFESSIONAL INTERESTS

Primary interests:

Geophysical Fluid Dynamics, Synchronized Chaos in Dynamical Systems,
Teleconnection Patterns, Self-Organization of the Climate System,
Data Assimilation, Inertial Manifolds

Other interests:

Machine Vision, Neural Networks, Foundations of Quantum Mechanics

EDUCATION

- **Ph.D., Astrophysical, Planetary, and Atmospheric Sciences**

University of Colorado, 1997

- major thesis topic: application of low-order synchronized chaos to the prediction of relationships between large-scale weather patterns in the Northern and Southern hemispheres, using a Green's function method to represent the time-lagged coupling between the corresponding quasigeostrophic midlatitude channel models, truncated to a small number of modes
- minor thesis topic: development of global entropy metric for cloud systems to enable the formulation of a second-law constraint on cloud morphogenesis based on water-cycle throughput

- **M.S., Astrophysical, Planetary, and Atmospheric Sciences**

University of Colorado, 1995

- **M.S., Physics**

State Univ. of NY at Stony Brook, 1981

- **B.S., Physics**

- **B.S., Math**

- **B.S., Chemistry**

Massachusetts Institute of Technology, 1976
(National Merit Scholar; Hertz Scholar)

PROFESSIONAL SCIENTIFIC EXPERIENCE**Visiting Scientist****National Center for Atmospheric Research**

2003-present

- co-Principal Investigator on 3-year grant under NSF's Collaborations in Mathematical Geosciences (CMG) program to apply chaos synchronization to data assimilation by synchronizing "truth" and "model", so as to improve on the Kalman filter in highly nonlinear regions of state space; lead author on the initial grant proposal

Postdoctoral Associate**Inst. for Mathematics and Its Applications**

2001-2003

- continued research on application of synchronized chaos to 1) climate dynamics and data assimilation in PDE systems with inertial manifolds; and 2) neural networks for combinatorial optimization

Postdoctoral Fellow/Visiting Scientist**National Center for Atmospheric Research**

1998-2000

- continued research in applications of synchronized chaos to 1) atmospheric teleconnections, using a QG channel model to show that inter-sectorial coupling of the small-scale flow components tend to synchronize the large scales and to predict conditions favorable to Atlantic-Pacific double blocking; and 2) reinterpretation of quantum mechanical Einstein-Podolsky-Rosen (EPR) correlations as synchronization of coupled deterministic systems

Graduate Research Assistant**University of Colorado, Boulder**

-planned and executed research tasks to support Ph.D. thesis

1993-1997

TEACHING EXPERIENCE**Consultant for undergraduate research****Meteorology Department, University of Maryland**

Summer 2004

- provided scientific expertise and mentoring for a small group of undergraduate women on a project under the Research Internships in Science and Engineering (RISE) program to encourage women to pursue scientific careers; the students compared synchronization and data assimilation as applied to a toy model

Visiting Assistant Professor**School of Mathematics, University of Minnesota**

Spring 2004

- taught two courses on advanced topics in elementary math for education majors, including number sequences, combinatorics, graph theory, probability, classical and analytic geometry

PROFESSIONAL ENGINEERING EXPERIENCE**Senior Staff Engineer****Hughes Aircraft Company, Canoga Park, CA**

1990-1991

- conceived and implemented improvements to neocognitron neural network architecture for translation-invariant object recognition

Principal Analyst

Ball Aerospace Systems Group, Boulder, CO

1987-1989

- developed scheme for low-level fusion of co-registered images from sensors of different types for improved recognition; validated using statistical binary-tree classifier
- conceived neural architecture for automatic stereo-matching based on combination of Hopfield optimization network and Grossberg FCS/BCS model of biological vision

Staff Engineer

Martin Marietta Corp., Orlando, FL and Denver, CO

1983-1987

- co-ordinated internal marketing activities to demonstrate capabilities of Artificial Intelligence Dept. to various program organizations within company
- developed proof-of-concept system for knowledge-based segmentation of road scenes for autonomous vehicle navigation
- knowledge-engineered a rule-based system to feedback information from automatic recognition system to assist in low-level delineation of objects in infra-red imagery

Engineer

General Dynamics Corp., San Diego, CA

1981-1983

- developed image segmentation algorithms, including a knowledge-based generalization of "superslice" algorithm for choice of grey-level threshold based on coincidence of thresholded object boundaries and detected edges

SERVICE

- Reviewer for: Quarterly Journal of the Royal Meteorological Society, Journal of Geophysical Research, Journal of the Atmospheric Sciences, Proceedings of the Royal Society of London, IEEE Trans. on Systems, Man, and Cybernetics
- Mentor for McNair Program, Univ. of Colo., to encourage outstanding undergraduates from non-traditional backgrounds to pursue graduate study
- Mentor program coordinator for McNair Program (salaried position): recruited graduate students to mentor McNair undergraduates and supervised the mentoring process
- Mentor for the scientific writing component of the SOARS (Significant Opportunities in Atmospheric Research and Science) program at NCAR to engage undergraduates from underrepresented groups in research in the atmospheric sciences

PUBLICATIONS

METEOROLOGY AND PHYSICS

refereed journal papers:

Duane, G.S., J.J. Tribbia, and J.B. Weiss, 2006: Synchronicity in predictive modelling: a new view of data assimilation, *Nonlin. Processes in Geophys.*, to appear

Yang, S.-C., D. Baker, H. Li, K. Cordes, M. Huff, G. Nagpal, E. Okereke, J. Villafañe, E. Kalnay, and G.S. Duane, 2006: Data assimilation as synchronization of truth and model: Experiments with the three-variable Lorenz system, *J. Atmos. Sci.*, **63**, 2340-2354.

Duane, G.S., 2005: Quantum nonlocality from synchronized chaos, *Int. J. Theor. Phys.*, **44**, 1917-1932.

Duane, G.S. and J.J. Tribbia, 2004: Weak Atlantic-Pacific teleconnections as synchronized chaos, *J. Atmos. Sci.*, **61**, 2149-2168.

Duane, G.S. and J.J. Tribbia, 2001: Synchronized chaos in geophysical fluid dynamics, *Phys. Rev. Lett.*, **86**, 4298-4301.

Duane, G.S., 2001: Violation of Bell's inequality in synchronized hyperchaos, *Found. Phys. Lett.*, **14**, 341-353.

Duane, G.S., P.J. Webster, and J.B. Weiss, 1999: Co-occurrence of Northern and Southern Hemisphere blocks as partially synchronized chaos, *J. Atmos. Sci.*, **56**, 4183-4205.

Duane, G.S., 1997: Synchronized chaos in extended systems and meteorological teleconnections, *Phys. Rev. E*, **56**, 6475-6493.

Duane, G.S., and J.A. Curry, 1997 : Entropy of a convecting water-air system and the interpretation of cloud morphogenesis, *Quart. J. Roy. Met. Soc.*, **123**, 605-629.

conference paper:

Duane, G.S., 2002: Synchronized chaos in climate dynamics, (invited talk) *Proc. 7th Experimental Chaos Conference*, ed. V. In et al., AIP Conference Proceedings 676, Melville, NY, 115-126.

submitted:

Duane, G.S., Yu, D.-C., and Kocarev, L, 2006: Identical synchronization, with translation invariance, implies parameter estimation, submitted to *Phys. Rev. Lett.*

IMAGE PROCESSING, MACHINE VISION,
ARTIFICIAL INTELLIGENCE, AND NEURAL NETWORKS

refereed journal paper:

Wolfe, W.J., D. Mathis, C. Anderson, J. Rothman, M. Gottler, G. Brady, R. Walker, G. Duane, G. Alaghband, 1991: K-Winner Networks, *IEEE Trans. on Neural Networks*, **2**, 310-315.

conference papers:

Duane, G., 1988: Pixel-level sensor fusion for improved object recognition, *Proc. of the SPIE*, **931**, 180-185.

Bloom, B.C., G.S. Duane, M.A. Epstein, M. Magee, D.W. Mathis, M.J. Nathan, W.J. Wolfe, 1988: Intertwining of teleoperation and computer vision, *Proc. of the SPIE*, **852**, 329-336.

Duane, G.S., 1986: Knowledge-based segmentation of road scenes, *Proc. of the SPIE*, **697**, 250-259.

Duane, G.S., S.F. Venable, D.J. Richter, and A.M. Wiedemann, 1985: A production system for scene analysis and semantically guided segmentation, *Proc. of the SPIE*, **548**, 35-45.

PERSONAL WEBSITE: <http://www.cgd.ucar.edu/~gduane>