Dan Lu

Contact Information

Climate Change Science Institute
Oak Ridge National Laboratory
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Research Interests

- Uncertainty quantification and risk assessment of hydrologic and climate models
- Numerical simulation of groundwater flow and contaminant reactive transport
- Computational methods and algorithms for inverse modeling
- Hierarchical Bayesian inference and statistical methods
- Design of experiments

Education

Ph.D. in Computational Science — April 2012
with a specialty in Computational Hydrology
Florida State University, Tallahassee, FL
Advisor: Professor Ming Ye
Dissertation title: *Assessment of parametric and model uncertainty in groundwater modeling*

M.S. in Hydrology and Water Resources — June 2007
China University of Geosciences, Beijing, China
Advisor: Professor Wenpeng Li
Thesis title: *Using GIS and remote sensing techniques to analyze soil salinization in Yanqi Basin*

B.S. in Environmental Engineering — June 2004
Hebei University of Geosciences, Shijiazhuang, China

Research Experience

Research Scientist — Oct. 2016 – Present
Climate Change Science Institute
Oak Ridge National Laboratory

Postdoctoral Research Associate — Dec. 2013 – Sept. 2016
Climate Change Science Institute
Oak Ridge National Laboratory
Mentors: Dr. Clayton Webster and Dr. Daniel Ricciuto

Postdoctoral Research Associate — May 2012 – May 2013
U.S. Geological Survey, Menlo Park, CA
Mentor: Dr. Gary Curtis

Graduate Research Assistant — Aug. 2007 – Apr. 2012
Department of Scientific Computing
Florida State University
Advisor: Dr. Ming Ye

Internship Researcher Jul. 2010 – Dec. 2010
U.S. Geological Survey, Boulder, CO
Mentor: Dr. Mary C. Hill

JOURNAL ARTICLES (PUBLISHED & ACCEPTED)

M. Xi, **D. Lu**, D. Gui, Z. Qi and G. Zhang, *Calibration of an Agricultural-Hydrological Model (RZWQM2) Using Surrogate Global Optimization*, **Journal of Hydrology**, to appear in 2016.

D. Lu, G. Zhang, C. Webster, and C. Barbier, *An Improved Multilevel Monte Carlo Method for Estimating Probability Distribution Functions in Stochastic Oil Reservoir Simulations*, **Water Resources Research**, to appear in 2016.

(This work was reported in *The BAKKEN Magazine in 2015* [online version])

P. Liu, M. Ye, P. Beerli, X. Zeng, **D. Lu**, and Y. Tao, *Evaluate Model Probability Using Markov Chain Monte Carlo with Thermodynamics Integration*, **Water Resources Research**, Vol. 52(2), pp. 734–758, 2016.

M. C. Hill, D. Kavetski, M. Clark, M. Ye, M. Arabi, **D. Lu**, L. Foglia, and S. Mehl, *Practical Use of Computationally Frugal Model Analysis Methods*, **Ground Water**, Vol. 54(2), pp. 59–170, 2016.

D. Lu, M. Ye, and G. P. Curtis, *Maximum Likelihood Bayesian Model Averaging and Its Predictive Analysis for Groundwater Reactive Transport Models*, **Journal of Hydrology**, Vol. 529(3), pp. 1859–1873, 2015.

D. Lu, M. Ye, M. C. Hill, E. P. Poeter, and G. P. Curtis, *A Computer Program for Uncertainty Analysis Integrating Regression and Bayesian Methods*, **Environmental Modeling & Software**, Vol. 60, pp. 41–56, 2014.

G. Zhang, **D. Lu**, M. Ye, M. Gunzburger, and C. Webster, *An Adaptive Sparse-Grid High-Order Stochastic Collocation Method of Bayesian Inference in Groundwater Reactive Transport Modeling*, **Water Resources Research**, Vol. 49(10), pp. 6871–6892, 2013.

D. Lu, M. Ye, P. D. Meyer, G. P. Curtis, X. Shi, X. Niu, and S. B. Yabusaki, *Effects of Error Covariance Structure on Estimation of Model Averaging Weights and Predictive Performance*, **Water Resources Research**, Vol. 49(9), pp. 6029–6047, 2013.

M. C. Hill, D. Kavetski, M. Clark, M. Ye, and **D. Lu**, *Uncertainty Quantification for Environmental Models*, **SIAM News**, Vol. 45(9), 2012.

D. Lu, M. C. Hill, and M. Ye, *Analysis of Regression Confidence Intervals and Bayesian Credible Intervals for Uncertainty Quantification*, **Water Resources Research**, Vol. 48(9), W09521, 2012.

(This paper was selected as *Editor's Highlight* entitled new insights into faster computation of uncertainties)

D. Lu, M. Ye, S. P. Neuman, and L. Xue, *Multimodel Bayesian Analysis of Data-Worth Applied to Unsaturated Fractured Tuffs*, **Advances in Water Resources**, Vol. 35, pp. 69–82, 2012.

S. P. Neuman, L. Xue, M. Ye, and **D. Lu**, *Bayesian Analysis of Data-Worth Considering Model and Parameter Uncertainties*, **Advances in Water Resources**, Vol. 36, pp. 75–85, 2012.

(*Top 10 Cited Paper* in 2012-2013 of Advances in Water Resources [Certificate])

D. Lu, M. Ye, and S. P. Neuman, *Dependence of Bayesian Model Selection Criteria and Fisher Information Matrix on Sample Size*, **Mathematical Geoscience**, Vol. 43, pp. 971–993, 2011.

M. Ye, **D. Lu**, S. P. Neuman, and P. D. Meyer, *Comment on "Inverse groundwater modeling for hydraulic conductivity estimation using Bayesian model averaging and variance window" by Frank T.-C. Tsai and Xiaobao Li*, **Water Resources Research**, Vol. 46, W02801, 2010.

Journal Articles (In Progress)

S. Mo, **D. Lu**, X. Shi, and J. Wu, *An Adaptive Sampling Strategy For Data Interpolation Using Radial Basis Functions*, **Water Resources Research**, submitted.

D. Lu, M. Stoyanov, G. Zhang, and C. Webster, *TASMANIAN: A Software for High-Dimensional Surrogate Modeling in Uncertainty Quantification*, in preparation.

D. Lu, and D. Ricciuto, *A Bayesian Calibration of a Ecosystem Carbon Model: A Comparative Study of Markov Chain Monte Carlo Methods*, in preparation.

Refereed Conference Publications

G. Zhang, **D. Lu**, M. Ye, M. Gunzburger, and C. Webster, *An Efficient Surrogate Modeling Approach in Bayesian Uncertainty Analysis*, 11th International Conference of Numerical Analysis and Applied Mathematics, Vol. 1558, pp. 898–901, 2013.

M. Ye, **D. Lu**, S. P. Neuman, and L. Xue , *Multimodel Bayesian Analysis of Data-Worth Applied to Unsaturated Fractured Tuffs*, International Conference on Groundwater: Our Source of Security in an Uncertain Future, Pretoria, South Africa, 2011.

D. Lu, M. C. Hill, and M. Ye, *Analysis of Regression and Bayesian Predictive Uncertainty Measures*, MODFLOW and More 2011 Conference, Golden, CO, 2011.

S. P. Neuman, L. Xue, M. Ye, and **D. Lu**, *Multimodel Assessment of the Worth of Data under Uncertainty*, Water Management Symposium, Phoenix, AZ, 2011.

M. Ye, **D. Lu**, G. Miller, G. P. Curtis, P. D. Meyer, and S. B. Yabusaki, *Assessment of Predictive Uncertainty in Coupled Groundwater Reactive Transport Modeling*, Conference on Goldschmidt – Earth, Energy and Environment, Knoxville, TN, 2010.

Technical Reports

C. Barbier, **D. Lu**, N. Collier, F. Curtis, C. G. Webster, and Y. Polsky, *High Performance Computing Simulations for Shale Gas Formation Flow Transport and Uncertainty Quantification Analysis*, ORNL Technical Report, ORNL/TM-2015/543, 2015.

Software Development

UCODE_2014: A Computer Code for Universal Sensitivity Analysis, Calibration, and Uncertainty Evaluation

Sponsor: U.S. Geological Survey

Developers: Eileen P. Poeter, Mary C. Hill, **Dan Lu**, and Steffen Mehl

Webpage: http://igwmc.mines.edu/freeware/ucode/

Description: UCODE is one of a set of inverse modeling codes supported by the U.S. Geological Survey. UCODE was developed for models in which the number of parameters is less than the number of observations. It can be used with existing process models to perform sensitivity analysis, data needs assessment, model calibration, prediction and uncertainty quantification.

Oral Presentations

A Systematic Bayesian Framework for Uncertainty Quantification in Environmental Modeling, Earth System Modeling Workshop, Oak Ridge National Laboratory, TN, 2015.

Multilevel Monte Carlo Method with Application to Uncertainty Quantification in Oil Reservoir Simulation, 47th American Geophysics Union Annual Meeting, San Francisco, CA, 2014.

Assessment of Predictive Performance of Bayesian Model Averaging in Groundwater Reactive Transport Models, 2014 SIAM Conference on Uncertainty Quantification, Savannah, GA, 2014.

Maximum Likelihood Bayesian Model Averaging of Groundwater Reactive Transport Models, 2014 SIAM SEAS Annual Meeting, Melbourne, FL, 2014.

Integration of Markov Chain Monte Carlo Simulation into UCODE for Bayesian Uncertainty Analysis, Geological Society of America Annual Meeting, Charlotte, NC, 2012.

Effects of Temporal Error Correlation on Quantification of Predictive Uncertainty in Groundwater Reactive Transport Modeling, annual PI meeting of the Subsurface Biogeochemical Research Program of the Department of Energy, Washington D.C., 2012.

Effects of Temporal Residual Correlation on Model Weights, 44th American Geophysics Union Annual Meeting, San Francisco, CA, 2011.

Multimodel Bayesian Analysis of Data-Worth Applied to Unsaturated Fractured Tuffs, Geosciences Applications Opening Workshops on Uncertainty Quantification, Research Triangle Park, NC, 2011.

Analysis of Predictive Uncertainty Measures of Regression and Bayesian, 2011 MODFLOW and More Meeting, Golden, CO, 2011.

A Controlled Experiment for Investigating Prediction Accuracy and Prediction Uncertainty in Groundwater Flow Modeling, 43th American Geophysics Union Annual Meeting, San Francisco, CA, 2010.

Teaching Experience

Instructor May 2015
Short course in MODFLOW and More 2015 Conference, Golden, CO
Role: prepared class lectures and exercises.

Teaching Assistant May 2011
Short course in MODFLOW and More 2011 Conference, Golden, CO
Role: Guided students through class exercises.

Teaching Assistant Fall 2007 and Spring 2008

Department of Scientific Computing
Florida State University
Course: *Scientific Programming*
Role: Provided assistance to students with homework; Assisted with class notes; Graded homework and exams; and Held office hours.

Teaching Interests

– Mathematical and numerical groundwater modeling
– Uncertainty analysis and risk assessment in environmental sciences
– Principles of hydrology
– Bayesian inferences and statistics

Honors and Awards

Student Travel Fellowship to the Annual PI meeting of the Subsurface Biogeochemical Research Program of the Department of Energy, 2012.

Statistical and Applied Mathematical Sciences Institute (SAMSI) Travel Award to the Geosciences Applications Opening Workshops on Uncertainty Quantification, 2011

Graduate Student Scholarship for Academic Excellence, China University of Geosciences, China, 2004–2007

Excellent Undergraduate Student of Hebei Province, China, 2003

Undergraduate Student Scholarship for Academic Excellence, Hebei University of Geosciences, China, 2000–2004

Reviewer for journals

Water Resources Research
Stochastic Environmental Research and Risk Assessment
Environmental Modeling & Software
Analytical Chemistry
Journal of Hydrology
Hydrogeology Journal

Memberships

American Geophysical Union (AGU)
Geologic Society of America (GSA)
Society for Industrial and Applied Mathematics (SIAM)
Chinese American Water Resources Association (CAWRA)