

EDUCATION

2013 Ph.D. – University of Arizona

Major: Hydrology and Water Resources
Minor: Applied Mathematics (Probability & Statistics)
Advisor: Hoshin V. Gupta (Regents' Professor)
Dissertation Title: *Diagnostics and Generalizations for Parametric State Estimation*

2009 M.S. – University of Arizona –

Major: Agricultural and Biosystems Engineering
Advisors: Donald C. Slack & M. Susan Moran

2006 B.S. – Purdue University

Major: Mathematics
Minor: Music History & Theory

PROFESSIONAL EXPERIENCE

- 2020 – Present: Assistant Professor; University of California Davis
Department of Land, Air, and Water Resources
- 2020 – Present: Visiting Faculty; Google Research
- 2017 – 2020: Assistant Professor; University of Alabama
Department of Geological Sciences
- 2016 – 2020: Research Assistant Professor (adjunct); University of Maryland Baltimore
County, Department of Computer Science and Electrical Engineering
- 2015 – 2017: Project Scientist; National Center for Atmospheric Research
- 2013 – 2017: Research Scientist; Science Systems and Applications Inc. &
Science Applications International Corp.
NASA Goddard Space Flight Center

COMPETITIVE FUNDING

- 2020: (Co-PI) NRCS Grazing Land CEAP (\$388,791)
- 2018: (PI) NCAR COMET National Water Center Cooperative Project (\$39,129): *Process Diagnostics and Efficient Parameter Estimation for Distributed Hydrologic Models with WRF-Hydro*
- 2017: (PI) NASA ROSES Terrestrial Hydrology Program (\$408,464): *Multivariate Hydrologic Data Assimilation for Model Structural Learning and Process-Diagnostics*
- 2016: (Co-I) NASA ROSES Advanced Information Systems Technology (Co-I Share = \$31,565): *Climate Risks in the Water Sector: Advancing the Readiness of Emerging Technologies in Climate Downscaling and Hydrologic Modeling*
- 2014: (Co-I) NASA Earth Science Technology Office; Advanced Information Systems Technology: *Quantum Annealing Computing for Carbon Data Assimilation in the LIS Model*

- 2014: (PI) NSF Geosciences; EAR Postdoctoral Fellowship (\$174,000; awarded but declined by PI): *Information-Based Diagnostics of Land Surface Models for Prediction Under Climate Change*
- 2014: (Science-PI) NASA Earth Science Technology Office; Quick Response Submission (\$98,000): *Next Generation Data Assimilation Capabilities in a Mission Simulation Platform to Increase the Value of Terrestrial Remote Sensing Observations*
- 2012: NSF East Asia and Pacific Summer Institute; Graduate Student Fellowship (\$4,500)
- 2011 & 2012: Achievement Rewards for College Scientists (\$11,000 x 2 separate awards)

TEACHING EXPERIENCE

- *Sustainable Earth* (GEO-105); Undergraduate; Enrollment = 80 – 110; Student Instructor Evaluation = 4.52, 4.36, 4.44 (dept. avg. = 4.20; college avg. = 4.19)
- *Geostatistics* (GEO-425/525); Undergraduate/Graduate; Enrollment = 18; Student Instructor Evaluation = 4.46

MENTORING EXPERIENCE

- 2018: Primary supervisor of two PhD students and one MS student.
- 2014 – 2019: Member of thesis/dissertation committees at University of Washington (completed 2021) and Georgia Tech (completed 2019).
- 2017 – 2018: Supervised three undergraduate research students. All three students presented their work as first authors at the 2018 AGU Fall Meeting.
- 2008 – 2009: NASA Space Grant Mentor; supervised one 9-month undergraduate research project.

PROFESSIONAL SERVICE

2019: Organizing committee and lecturer at the SITES Summer School on Information Theory in the Earth Sciences; Santander, Spain; <http://sites-2019.ihcantabria.com>

2018: Water Resources Research Editor's Citation for Excellence in Refereeing; <https://eos.org/agu-news/in-appreciation-of-agus-outstanding-reviewers-of-2017>

2018: Organizing committee for the NASA Goddard Workshop on Artificial Intelligence; <https://asd.gsfc.nasa.gov/conferences/ai/>

2017 – 2018: NASA Goddard Artificial Intelligence Working Group

2016 & 2018: Co-Organized two special issues of Water Resources Research

- 2016: *Engagement, Communication, and Decision-Making Under Uncertainty*
- 2018: *Big Data & Machine Learning in Water Sciences*

2016 - 2020: Organizing committee – workshop series on Information Theory in the Earth Sciences:

- 2016: 1st Workshop – Karlsruhe Institute of Technology, Germany

- 2018: 2nd Workshop – Environmental Hydraulics Institute Cantabria, Spain
- 2019: 3rd Workshop – Environmental Hydraulics Institute Cantabria, Spain
- 2020: 4th Workshop – Northern Arizona University, Flagstaff, AZ USA

2015 – 2017: Secretary (3rd ranking member) of the American Geophysical Union Hydrology Section Technical Committee on Uncertainty Quantification (2-year rotating appointments)

FULL LIST OF JOURNAL ARTICLES (*h-index: Web of Science=13; Google=16*)

----- In Review -----

- M. Rahman, J.M. Frame, J. Lin **G.S. Nearing**; Hidden Stories: Topic Modeling in Hydrology Literature. *in review at Water Resources Research*.
- J.M. Frame, **G.S. Nearing**, F. Kratzert, A. Raney, M. Rahman, F. Salas; Post processing the U.S. National Water Model with a Long Short-Term Memory network. *in review at Journal of American Water Resources Association*.
- M. Gauch, F. Kratzert, D. Klotz, **G.S. Nearing**, J. Lin, S. Hochreiter; Rainfall–Runoff Prediction at Multiple Timescales with a Single Long Short-Term Memory Network *in review at Hydrology and Earth System Sciences Discussions*.

----- 2021 -----

1. F. Kratzert, D. Klotz, S. Hochreiter, **G.S. Nearing**; A Note on Leveraging Synergy in Multiple Meteorological Datasets with Deep Learning for Rainfall-Runoff Modeling? *in review at Hydrology and Earth System Sciences Discussions*.

----- 2020 -----

2. **G.S. Nearing**, F. Kratzert, A.K. Sampson, C.S. Pelissier, D. Klotz, J.M. Frame, H.V. Gupta; What role does hydrological science play in the age of machine learning? *Water Resources Research* (Q1; IF=2.60) November, 2020
3. C.S. Pelissier, J.M. Frame, **G.S. Nearing**; Combining Parametric Land Surface Models with Machine Learning; *Proceedings of IGARSS 2020*.
4. **G.S. Nearing**, C.S. Pelissier, F. Kratzert, H.V. Gupta, A.K. Sampson, D. Klotz; Physically-Based Machine Learning for Hydrological Modeling; *44th NOAA Climate Diagnostics and Prediction Workshop*
5. J. Qiu, W.T. Crow, J. Dong, **G.S. Nearing**; Land Surface Model Representation of the Mutual Information Context between Multi-Layer Soil Moisture and Evapotranspiration; *in review at Hydrology and Earth Systems Science* (Q1; IF=2.02) February, 2020.
6. **G.S. Nearing**, B.L. Ruddell, A.R. Bennett, C. Prieto, H.V. Gupta; Debates: Does Information Theory Provide a New Paradigm for Earth Science? Hypothesis Testing; *Water Resources Research Research* (Q1; IF=2.60), January 2020.

----- 2019 -----

7. F. Kratzert, D. Klotz, M. Herrnegger, A.K. Sampson, S. Hochreiter, **G.S. Nearing***; Prediction in Ungauged Basins with Long Short-Term Memory Networks; *Water Resources Research* (Q1; IF=2.60), November 2019 (*corresponding author).
8. F. Kratzert, D. Klotz, G. Shalev, G. Klambauer, S. Hochreiter*, **G.S. Nearing***; Benchmarking a Catchment-Aware Long Short Term Memory Network (LSTM) for Large-Scale Hydrological Modeling; *Hydrology and Earth System Science* (Q1; IF=2.02), November 2019 (*shared supervising author).
9. B.L. Ruddell, D.T. Drewry, **G.S. Nearing**; Process diagnostics as tradeoffs between functional and predictive performance in complex ecohydrology models using information transfer metrics; *Water Resources Research* (Q1; IF=2.60), August 2019.
10. A.R. Bennett, B. Nijssen, G.O. Ou, M.P. Clark, **G.S. Nearing**; Quantifying process connectivity with transfer entropy in hydrologic models; *Water Resources Research* (Q1; IF=2.60), April 2019.
11. S. Yatheendradas, D. Kirschbaum, **G.S. Nearing**, J. Vrugt, R. Baum, R. Wooten, N. Lu, B. Cosgrove; Sensitivity of modeled slope failure uncertainty to rain data sources over North Carolina; *Computational Geosciences* (Q1; IF=0.99), January 2019.

----- 2018 -----

12. C. Prieto, U. Ehret, **G.S. Nearing**; An Information Approach to the Earth Sciences; *EOS, Transactions, American Geophysical Union* (Q2; IF=0.38), September 2018.
13. **G.S. Nearing**, B.L. Ruddell, M.P. Clark, B. Nijssen, C.D. Peters-Lidard; Benchmarking & Process Diagnostics of Land Models; *Journal of Hydrometeorology* (Q1; IF=2.24), September 2018.
14. N. Addor; **G.S. Nearing**; C. Prieto; A. Newman; N. Le Vine; M. Clark; A Ranking of Hydrological Signatures Based on Their Predictability in Space; *Water Resources Research* (Q1; IF=2.60), September 2018.
15. **G.S. Nearing**, S. Yatheendradas, W.T. Crow, X. Zhan, J. Liu, F. Chen; The Efficiency of Data Assimilation; *Water Resources Research* (Q1; IF=2.60), July 2018. **Selected for AGU Research Spotlight.**
16. K. Arsenault, **G.S. Nearing**, S. Wang, S. Yatheendradas, C.D. Peters-Lidard; Parameter Sensitivity of the Noah-MP Land Surface Model with Dynamic Vegetation; *Journal of Hydrometeorology* (Q1; IF=2.24), April 2018.
17. **G.S. Nearing**, H.V. Gupta; Ensembles vs. Information Theory: Supporting Science under Uncertainty; *Frontiers of Earth Science* (Q1; IF=1.25), April 2018.

----- 2017 -----

18. R. Hooper, **G.S. Nearing**, L.S. Condon; Using the National Water Model as a Hypothesis- Testing Tool; *Open Water Journal* (journal not ranked), November 2017.
19. A.J. Newman, N. Mizukami; M.P. Clark, A.W. Wood, B. Nijssen, **G.S. Nearing**; Benchmarking of A Physically Based Hydrology Model; *Journal of Hydrometeorology*

(Q1; IF=2.24), August 2017.

20. **G.S. Nearing**, S. Yatheendradas, W.T. Crow, D.D. Bosch, M.H. Cosh, D.C. Goodrich, P.J. Starks, M.S. Seyfried; Nonparametric Triple Collocation; *Water Resources Research* (Q1; IF=2.60), May 2017.

----- 2016 -----

21. J. Qiu, W.T. Crow, **G.S. Nearing**; The Impact of Vertical Measurement Depth on the Information Content of Soil Moisture for Latent Heat Flux Estimation; *Journal of Hydrometeorology* (Q1; IF=2.24), September 2016.
22. **G.S. Nearing**, Y. Tian, H.V. Gupta, M.P. Clark, S.V. Weijis, K.W. Harrison; A Philosophical Basis for Hydrologic Uncertainty; *Hydrological Sciences Journal* (Q1; IF=0.94), July 2016.
23. **G.S. Nearing**, D.M. Mocko, C.D. Peters-Lidard, S.V. Kumar, Y. Xia; Benchmarking NLDAS-2 Soil Moisture and Evapotranspiration to Separate Uncertainty Contributions; *Journal of Hydrometeorology* (Q1; IF=2.24), March 2016.
24. Y. Tian, **G.S. Nearing**, C.D. Peters-Lidard, K.W. Harrison, L. Tian; Performance Metrics, Error Modeling, and Uncertainty Quantification; *Monthly Weather Review* (Q1; IF=2.64), February 2016.

----- 2015 -----

25. S.V. Kumar, et al.; Evaluating the Utility of Satellite Soil Moisture Retrievals over Irrigated Areas and the Ability of Land Data Assimilation Methods to Correct for Unmodeled Processes; *Hydrology and Earth System Science* (Q1; IF=2.02), November 2015.
26. N. Haughton, et al.; The Plumbing of Land Surface Models: Is Poor Performance a Result of Methodology or Data Quality? *Journal of Hydrometeorology* (Q1; IF=2.24), June 2015.
27. M.J. Best, et al.; The Plumbing of Land Surface Models. *Journal of Hydrometeorology* (Q1; IF=2.24), June 2015.
28. **G.S. Nearing**, H.V. Gupta; The Quantity and Quality of Information in Hydrologic Models. *Water Resources Research* (Q1; IF=2.60), January 2015.

----- 2014 -----

29. J. Qiu, W.T. Crow, **G.S. Nearing**, X. Mo, S. Liu; The Impact of Vertical Measurement Depth on the Information Content of Soil Moisture Time Series Data. *Geophysical Research Letters* (Q1; IF=2.66), July 2014.
30. **G.S. Nearing**; Comment on "A blueprint for process-based modeling of uncertain hydrological systems" by Montanari and Koutsoyiannis. *Water Resources Research* (Q1; IF=2.60), July 2014.
31. W. Gong, D. Yang, H.V. Gupta, **G.S. Nearing**; Estimating Information Entropy for Hydrologic Data: One-Dimensional Case. *Water Resources Research* (Q1; IF=2.60), June 2014.

32. H.V. Gupta, **G.S. Nearing**; Debates on Water Resources: Using Models and Data to Learn – A Systems Theoretic Perspective on the Future of Hydrological Science. *Water Resources Research* (Q1; IF=2.60), June 2014.

----- 2013 -----

33. **G.S. Nearing**, H.V. Gupta, W.T. Crow; Information Loss in Approximately Bayesian Estimation Techniques: A Comparison of Generative and Discriminative Approaches to Estimating Agricultural Productivity. *Journal of Hydrology* (Q1; IF=1.83), December 2013.
34. **G.S. Nearing**, H.V. Gupta, W.T. Crow, W. Gong; An Approach to Quantifying the Efficiency of a Bayesian Filter. *Water Resources Research* (Q1; IF=2.60), April 2013.
35. **G.S. Nearing**, M. Tuller, S.B. Jones, R. Heinse, M.S. Meding; Electromagnetic Induction for Mapping Physical and Chemical Properties of Mine Tailings Deposits. *Journal of Applied Geophysics* (Q2; IF=0.64), February 2013.

----- 2012 -----

36. **G.S. Nearing**, W.T. Crow, K.R. Thorp, M.S. Moran, R.R. Reichle, H.V. Gupta; Assimilating Remote Sensing Observations of Leaf Area Index and Soil Moisture for Wheat Yield Estimates: An Observing System Simulation Experiment. *Water Resources Research* (Q1; IF=2.60), May 2012.
37. **G.S. Nearing**, M.S. Moran, R.L. Scott, G.E. Ponce-Campos; Coupling Diffusion and Maximum Entropy Models to Estimate Thermal Inertia and Soil Moisture. *Remote Sensing of Environment* (Q1; IF=3.12), April 2012.
38. K.R. Thorp, J.W. White, C.H. Porter, G. Hoogenboom, **G.S. Nearing**, A.N. French; Methodology to Evaluate the Performance of Simulation Models for Alternative Compiler and Operating System Configurations. *Computers and Electronics in Agriculture* (Q1; IF=0.81), February 2012.

----- 2010 -----

39. **G.S. Nearing**, M.S. Moran, K.R. Thorp, C.D. Holifield-Collins, D.C. Slack; Likelihood Parameter Estimation for Calibrating a Soil Moisture Model Using Radar Backscatter. *Remote Sensing of Environment* (Q1; IF=3.12), Nov 2010.
40. M.S. Moran, et al.; Hydrologic Response to Precipitation Pulses Under and Between Shrubs in the Chihuahuan Desert, Arizona. *Water Resources Research* (Q1; IF=2.60), October 2010.

----- 2009 -----

41. M.S. Moran, et. al; Partitioning Evapotranspiration in Semiarid Grassland and Shrubland Ecosystems Using Time Series of Soil Surface Temperature. *Agricultural and Forest Meteorology* (Q1; IF=1.82), January 2009.

PEER REVIEWED BOOK CHAPTERS & CONFERENCE PROCEEDINGS

42. H. Moradkhani, **G.S. Nearing**, P. Abbaszadeh, S. Pathiraja; Fundamentals of Data Assimilation and Theoretical Advances; in Duan, Pappenberger, Thielen, Wood, Cloke (Eds) *Handbook of Hydrometeorological Ensemble Forecasting*, Springer, Berlin, accepted February 2019.
43. **G.S. Nearing**; Estimating Probability Distributions for Hydrometeorological Applications; in Duan, Pappenberger, Thielen, Wood, Cloke (Eds) *Handbook of Hydrometeorological Ensemble Forecasting*, Springer, Berlin, accepted February 2019.
44. Mladenova, **G.S. Nearing**, J. Bolten, V. Lakshmi; Chapter 7: Remote Sensing Techniques and Data Assimilation for Hydrological Modeling; in Singh (Ed) *Handbook of Hydrology*, McGraw-Hill Education, 2016.
45. **G.S. Nearing**, C.L. Winter, D.M. Tartakovsky; A Conditional Probability Model for Groundwater Risk Assessment; in Carrera (Ed) *Proceedings of the XVIIIth International Conference on Computation Methods in Water Resources*, Barcelona Spain, January 2010.

INVITED CONFERENCE PRESENTATIONS

(invited only - contributed or submitted abstracts not listed)

1. Hydrological Modeling with Deep Learning (Invited) at the American Meteorological Society's 35th Conference on Hydrology, virtual, January 2021.
2. Machine Learning is Central to the Future of Hydrological Modeling at the European Geosciences Union Annual Meeting, virtual, April 2020
3. Keynote talk at Google's 'Flood Forecasting Meets Machine Learning' Workshop; February, 2020; Tel Aviv, Israel
4. Keynote Talk: *Physically Based Machine Learning for Hydrological Modeling*; NOAA 44th Annual Climate Diagnostics and Prediction Workshop; October 2019; Durham, NC, USA; Meeting Program:
www.cpc.ncep.noaa.gov/products/outreach/CDPW/44/programs/cdpw44_oral_presentations.pdf
5. *Multivariate Data Assimilation with Machine Learning for Streamflow Modeling*; American Geophysical Union Fall Meeting; December 2019; San Francisco, CA, USA
6. Keynote Talk: *Using Embedding Layers in Deep Learning Networks to Understand and Complexity, Similarity, and Nonstationarity in Rainfall/Runoff Processes*; European Geoscience Union 10th Leonardo Conference; October 2019; Esch-sur-Alzette, Luxembourg
7. *The Need for Physics-Informed Machine Learning in Hydrology* NSF TRIPODS 2nd Southwest Summer Conference; May 2019; Tucson, AZ, USA; Meeting Website: sites.google.com/math.arizona.edu/tripodsummerconference2019
Lecture Video:
arizona.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=04093bcf-ebf8-4004-9674-aa5401684291
8. *Calibrating a Terrestrial Hydrology Model for Process-Realism*; American Geophysical Union Fall Meeting; December 2018; Washington DC, USA

9. *Process-Based Models under Nonstationarity*; American Geophysical Union Fall Meeting; December 2018; Washington DC, USA
10. *Diagnosing Earth Systems Models: Confirmatory Data Analytics with Machine Learning*; NASA AMES Machine Learning Workshop; August 2017; Mountain View, CA, USA
11. *Uncertainty vs. Information*; European Geophysical Union General Assembly; April 2016; Vienna, Austria
12. *The Role of Data Assimilation in Model Diagnostics*; American Geophysical Union Fall Meeting; December 2016; San Francisco, CA, USA
13. *Understanding the Information Content of Remote Sensing Observations*; Annual Meeting of the Soil Science Society of America; November 2016; Phoenix, AZ, USA
14. *What does it mean to say that a model provides information?* European Geophysical Union General Assembly; April 2016; Vienna, Austria
15. *The Value of Data Assimilation for Dynamic Vegetation Monitoring in Land Surface Modeling*; American Geophysical Union Fall Meeting; December 2015; San Francisco, CA, USA
16. *Hunting Solomonoff's Swans: Exploring the Boundary Between Physics and Statistics in Hydrological Modeling*; American Geophysical Union Fall Meeting; December 2014; San Francisco, CA, USA
17. *The Amount and Quality of Information Provided by Models and Induction*; Society for Industrial and Applied Mathematics Conference on Uncertainty Quantification; April 2014; Savannah, GA, USA
18. *Information-Based Analysis of Data Assimilation*; American Geophysical Union Fall Meeting; December 2013; San Francisco, CA, USA
19. *Improving Yield Forecasting using Root Zone Soil Moisture*; Biological Systems Simulation Group 40th Annual Symposium; April 2010; Phoenix, AZ, USA