Peishi Jiang

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October 1, 2023

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Research Interests

As an ecohydrologist, my research interests lie in unleashing the power of data to study and understand the land process that integrates the water, energy, and carbon fluxes from surface canopy to belowground soil systems. I applied data-driven approaches to uncover the interdependencies of multivariate complex ecosystems using causal analysis and facilitate earth system modeling using deep learning. I am particularly interested in developing a hybrid modeling system that seamlessly couples data-driven approaches with process-based land models.

Education

- **University of Illinois at Urbana-Champaign** — Urbana, IL
  Ph.D. in Civil Engineering — *Aug. 2014 - May. 2019*

  Thesis title: Causal History Analysis of Complex System Dynamics. (Advisor: *Prof. Praveen Kumar*)

- **Hong Kong University of Science & Technology** — Hong Kong
  M.Phil. in Civil Engineering — *Feb. 2012 - Dec. 2013*

  Thesis title: Establishment of Rainfall Depth-Duration-Frequency Relationships at Conventional Raingauges & Ungauged Sites in Hong Kong. (Advisor: *Prof. Yeou-Koung Tung*)

- **Zhejiang University** — Hangzhou, China
  B.E. in Water Resources and Ocean Engineering — *Aug. 2007 - Jul. 2011*

Professional Experiences

- **Research Scientist** — *Sept. 2021 - Present*
  Pacific Northwest National Laboratory
- **Post Doctorate Research Associate** — *Jul. 2019 - Aug. 2021*
  Pacific Northwest National Laboratory
- **Non-Employment Researcher** — *Jun. 2021 - Aug. 2021*
  NASA Frontier Development Laboratory
- **Graduate Research Assistant** — *Aug. 2014 - May. 2019*
  University of Illinois at Urbana-Champaign
- **Research Assistant** — *Jan. 2014 - Jun. 2014*
  Hong Kong University of Science & Technology
- **Graduate Research Assistant** — *Feb. 2012 - Dec. 2013*
  Hong Kong University of Science & Technology
- **Researcher** — *Sep. 2011 - Dec. 2011*
  Zhejiang University

Grants Funded

- **PNNL Laboratory Directed Research and Development** — DOE
  Role: PI ($100,000) — *Oct. 2023 - Oct. 2024*

  Project: A differentiable hybrid land model for seamlessly integrating deep learning with physics-based components.

Services

- Served as a session convener of "Causal Inference in Hydrology" in AGU Fall Meetings 2022 & 2023.
- Served as a session chair of the hybrid modeling in DOE AI4ESP workshop, Sept. 2021 - Dec. 2021.
- Served as a member of AGU Hydrological Uncertainty Technical Committee, Jan. 2017 - Dec. 2018.

Peer-Reviewed Publications (published)

1. Moses B. Adebayo, Vanessa L. Bailey, Xingyuan Chen, Anya M. Hopple, **Peishi Jiang**, et al. (2023), "A hydrogeophysical framework to assess infiltration during a simulated ecosystem-scale flooding experiment", ***Journal of Hydrology***, [doi.org/10.1016/j.jhydrol.2023.130243].
2. **Peishi Jiang**, Zhao Yang, Jiali Wang, Chenfu Huang, Pengfei Xue, TC Chakraborty, Xingyuan Chen, and Yun Qian (2023), "Efficient Super-Resolution of Near-Surface Climate Modeling Using the Fourier Neural Operator", ***Journal of Advances in Modeling Earth Systems***, [doi.org/10.1029/2023MS003800].
3. **Peishi Jiang**, Pin Shuai, Alexandar Sun, Maruti K Mudunuru, and Xingyuan Chen (2023), "Knowledge-Informed Deep Learning for Hydrological Model Calibration: An Application to Coal Creek Watershed in Colorado", ***Hydrology and Earth System Sciences***, [doi.org/10.5194/hess-27-2621-2023].
4. **Peishi Jiang**, Xingyuan Chen, Justine EC. Missik, Brittany A Verbeke, Heping Liu, and Zhongming Gao (2022), "Encoding diel hysteresis and the Birch effect in dryland soil respiration models through knowledge-guided deep learning", ***Frontiers in Environmental Science***, [doi.org/10.3389/fenvs.2022.1035540].
5. Maruti K. Mudunuru, Kyongho Son, **Peishi Jiang**, Glenn Hammond, and Xingyuan Chen (2022), "Scalable deep learning for watershed model calibration", ***Frontiers in Earth Science***, [doi.org/10.3389/feart.2022.1026479].
6. **Peishi Jiang**, Kyongho Son, Maruti K. Mudunuru, and Xingyuan Chen (2022), "Using Mutual Information for Global Sensitivity Analysis on Watershed Modeling", ***Water Resources Research***, [doi.org/10.1029/2022WR032932].
7. Kewei Chen, Xingyuan Chen, Xuehang Song, Martin A. Briggs, **Peishi Jiang**, Pin Shuai, Glenn Hammond, Hongbin Zhan, and John M. Zachara (2022), "Using Ensemble Data Assimilation to Estimate Transient Hydrologic Exchange Flow Under Highly Dynamic Flow Conditions", ***Water Resources Research***, [doi.org/10.1029/2021WR030735].
8. Alexander Y Sun, **Peishi Jiang**, Zong-Liang Yang, Yangxinyu Xie, and Xingyuan Chen (2022) "A graph neural network (GNN) approach to basin-scale river network learning: the role of physics-based connectivity and data fusion", ***Hydrology and Earth System Sciences***, [doi.org/10.5194/hess-26-5163-2022].
9. Alexander Y Sun, **Peishi Jiang**, Maruti K Mudunuru, Xingyuan Chen (2021) "Explore Spatio-Temporal Learning of Large Sample Hydrology Using Graph Neural Networks", ***Water Resources Research***, [doi.org/10.1029/2021WR030394].
10. **Peishi Jiang**, Nis Meinert, Helga Jordão, Constantin Weisser, Simon Holgate, Alexander Lavin, Björn Lütjens, Dava Newman, Haruko Wainwright, Catherine Walker, Patrick Barnard (2021) "Digital Twin Earth–Coasts: Developing a fast and physics-informed surrogate model for coastal floods via neural operators", ***2021 NeurIPS Workshop on Machine Learning for the Physical Sciences (ML4PS)***, [arXiv:2110.07100].

11. **Peishi Jiang**, Xingyuan Chen, Kewei Chen, Jeffrey Anderson, Nancy Collins, and Mohamad EL Gharamti (2021) "DART-PFLOTRAN: An Ensemble-based Data Assimilation System for Estimating Subsurface Flow and Transport ModelParameters", ***Environmental Modelling and Software***, [doi.org/10.1016/j.envsoft.2021.105074].

12. Erol LD Cromwell, Pin Shuai, **Peishi Jiang**, Ethan Coon, Scott L Painter, David Moulton, Youzuo Lin, and Xingyuan Chen (2021) "Estimating Watershed Subsurface Permeability From Stream Discharge Data Using Deep Neural Networks", ***Frontiers in Earth Science***, [doi.org/10.3389/feart.2021.613011].

13. **Peishi Jiang** and Praveen Kumar (2020) "Bundled Causal History Interaction", ***Entropy***, [doi.org/10.3390/e22030360].

14. **Peishi Jiang** and Praveen Kumar (2020) "Using Information Flow for Whole System Understanding from Component Dynamics", ***Water Resources Research***, [doi.org/10.1029/2019WR025820].

15. Allison Goodwell, **Peishi Jiang**, Ben Ruddel and Praveen Kumar (2020) "Does Information Theory Provide a New Paradigm for Earth Science? Understanding Causality and Interaction.", ***Water Resources Research***, [doi.org/10.1029/2019WR024940].

16. **Peishi Jiang** and Praveen Kumar (2019) "Information Transfer from Causal History in Complex System Dynamics", ***Physical Review E***, [doi:10.1103/PhysRevE.99.012306].

17. **Peishi Jiang** and Praveen Kumar (2018) "Interactions of Information Transfer Along Separable Causal Paths", ***Physical Review E***, [doi:10.1103/PhysRevE.97.042310].

18. **Peishi Jiang**, Mostafa Elag, Praveen Kumar, Scott Dale Peckham, Luigi Marini, and Liu Rui (2017) "A Service-oriented Architecture for Coupling Web Service Models Using the Basic Model Interface (BMI)", ***Environmental Modelling & Software***, [doi:10.1016/j.envsoft.2017.01.021].

19. **Peishi Jiang** and Yeou-Koung Tung (2015) "Incorporating Daily Rainfalls to Derive Rainfall DDF Relationships at Ungaged Sites in Hong Kong and Quantifying Their Uncertainty", ***Stochastic Environmental Research and Risk Assessment***, [doi:10.1007/s00477-014-0915-2].

20. **Peishi Jiang** and Yeou-Koung Tung (2013) "Establishing Rainfall Depth-Duration-Frequency Relationships at Daily Raingauge Stations in Hong Kong", ***Journal of Hydrology***, [doi:10.1016/j.jhydrol.2013.09.037].

Conference Proceedings and White Papers

1. Sivasankaran Rajamanickam, Prasanna Balaprakash, **Peishi Jiang**, Jiali Wang and Nathan Urban (2022) "16 Hybrid Modeling", Artificial Intelligence for Earth System Predictability (AI4ESP) Workshop Report, No. ANL-22/54. Argonne National Lab.(ANL), Argonne, IL , [https://doi.org/10.2172/1888810].

2. **Peishi Jiang**, Xingyuan Chen, Maruti Mudunuru, Praveen Kumar, Pin Shuai, Kyongho Son and Alexander Sun (2021) "Towards Trustworthy and Interpretable Deep Learning-assisted Ecohydrological Models", DOE Artificial Intelligence for Earth System Predictability workshop, [https://doi.org/10.2172/1769787].

3. **Peishi Jiang** and Yeou-Koung Tung (2013) "Quantification of rainfall DDF relationships at ungauged sites in Hong Kong", World Environmental and Water Resources Congress 2013 Showcasing the Future, ASCE, [doi:10.1061/9780784412947.323].

Peer-Reviewed Publications (in review)

- Yadong Zhou, **Peishi Jiang**, Ping Chen, Endong Jia, Cole S. Welch, Qian Zhao, Jeffrey A. Dhas, Emily B. Graham, Xingyuan Chen, Xin Zhang, and Zihua Zhu (2023), "A novel PCA tool based on Python for analysis of complex ToF-SIMS spectra", ***Journal of Vacuum Science & Technology A***, in review.
- Bing Li, Zhi Li, Jianqiu Zheng, **Peishi Jiang**, et al. (2023), "Integrated Effects of Site Hydrology and Vegetation on Exchange Fluxes and Nutrient Cycling at a Coastal Terrestrial-Aquatic Interface", ***Water Resources Research***, in review.
- Pin Shuai, **Peishi Jiang**, Ethan Coon, and Xingyuan Chen (2023), "The Importance of Explicitly Representing the Streambed in Watershed Models", ***Hydrological Processes***, in review.

Invited talks

- *Applications of Deep Learning in Watershed Modeling*, ASGC Division Seminar, Pacific Northwest National Laboratory, Nov. 2022.
- *Neversink Watershed Modeling*, Seminar with USGS Integrated Modeling Team, Online, July. 2022.
- *An Information-Theoretic Framework for Unraveling the Dynamics of Self-Organization in Ecosystem*, Environmental Science Presentation, Argonne National Laboratory, Sept. 2018.

Presentations

- *Integrated Modeling of Carbon and Nitrogen Cycling at the Yakima River Basin*, Poster presentation at DOE ESS PI Meeting 2023, Bethesda, MD.
- *Zero-Shot Super-Resolution of WRF Surface Heat Simulation Using Fourier Neural Operator*, Poster presentation at AGU Fall Meeting 2022, Chicago, IL.
- *Hydrological Model Calibration Using Knowledge-Informed Deep Learning at Coal Creek Watershed, CO*, Poster presentation at HydroML 2022, Penn State University, State College, PA.
- *Building up Trustworthiness of Deep Learning-based Emulator for Environmental Process-based Model*, Oral presentation at AGU Fall Meeting 2022, Online.
- *Digital Twin Earth–Coasts: Developing a fast and physics-informed surrogate model for coastal floods via neural operators*, Poster presentation at 2021 NeurIPS Workshop on Machine Learning for the Physical Sciences, Online.
- *Leveraging the diel hysteresis between soil respiration and temperature to improve Rsoil modeling using bidirectional LSTM*, Oral presentation at PNNL Physics Informed Machine Learning Workshop, Online.
- *DART-PFLOTRAN: An Ensemble Data Assimilation System for Modeling Subsurface Process*, Oral presentation at AGU Fall Meeting 2020, Online.
- *Using Information Flow for Whole System Understanding from Component Dynamics*, Poster presentation at AGU Fall Meeting 2019, San Francisco, CA.
- *Unraveling the Causal Dynamics in Stream Solutes by Using an Information-Theoretic Approach*, Poster presentation at AGU Fall Meeting 2018, Washington, D.C..
- *Interactions of Information Transfer Along Separable Causal Paths*, Oral presentation at Entropy 2018: From Physics to Information Sciences and Geometry, Barcelona, Spain.

- *Understanding Information Flow Interaction along Separable Causal Paths in Environmental Signals*, Poster presentation at AGU Fall Meeting 2017, New Orleans, CA.
- *A Service-Oriented Architecture for Coupling Web Service Models Using the Basic Model Interfaces*, Poster presentation at CSDMS Annual Meeting 2017, Boulder, CO.
- *An Application of the Geo-Semantic Micro-services in Seamless Data-Model Integration*, Oral presentation at AGU Fall Meeting 2016, San Francisco, CA.
- *A Smart Modeling Framework for Integrating BMI-enabled Models as Web Services*, Poster presentation at AGU Fall Meeting 2015, San Francisco, CA.
- *GeoSemantic Resource Alignment Service*, Poster presentation at CSDMS Annual Meeting 2015, Boulder, CO.
- *Quantification of Rainfall DDF Relationships at Ungauged Sites in Hong Kong*, Oral presentation at World Environmental and Water Resources Congress (EWRI 2013), Cincinnati, Ohio.
- *Establishing Rainfall Depth-Duration-Frequency Relationships at Daily Raingauge Stations in Hong Kong*, Oral presentation at 2012 IAHR-HK Student Research Forum, Hong Kong.

Teaching Experience

- **ASGC machine learning bootcamp** — PNNL
  Instructor — *2022*
- **CEE450 Surface Hydrology** — UIUC
  Teaching Assistant — *2018*
- **CEE550 Hydroclimatology** — UIUC
  Teaching Assistant — *2017*
- **CIVL3530 Hydraulics** — HKUST
  Teaching Assistant — *2013*
- **CIVL3520 Hydrology** — HKUST
  Teaching Assistant — *2012*

Skills

- **Programming Language:** Python, UNIX, Fortran, Matlab, C, MPI for C, CUDA, JavaScript, Scala, R, Mathematica, SAS, LaTeX.
- **AI frameworks:** JAX, Pytorch, Keras-Tensorflow.
- **Web Technology:** RESTful web service, service-oriented architecture, semantic web technology, SQL database, basic web application design.